BIOSYSTEMATIC STUDIES ON PYRALID PESTS OF RICE CROP IN INDIA (PYRALIDAE: LEPIDOPTERA)

ABSTRACT

THESIS

Submitted for the Degree of Doctor of Philosophy

IN

Agricultural Entomology

By

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(INDIA)

2000

ABSTRACT

The present study carried out by the author on the "Biosystematic studies of family Pyralidae associated with rice crop in India" are presented in this thesis. In addition, studies were also conducted on the bionomics, population dynamics and natural parasitization of larvae and pupae of leaf folder, *Cnaphalocrocis medinalis* (Guenee) on Pusa Basmati rice cultivar under Delhi conditions.

The first chapter introduces the subject matter. This includes area, production and losses of rice crop due to insect pests especially of family Pyralidae. Economic importance, salient features and the necessity to carry out further work is highlighted.

The review of literature on the taxonomy and nomenclature of family Pyralidae and biology and ecology of leaf folder, *Cnaphalocrocis medinalis* (Guenee) constitute the second chapter. In this chapter chronological accounts of the work done by various workers are given. It is divided into three parts. In the first part, the nomenclature of the family and its division into different subfamilies are discussed, whereas the second part deals with the taxonomy of various genera and species. The third part deals with the work done on biology and ecology of leaf folder.

The source of the materials and the methods employed in connection with these studies are dealt with in the third chapter. Herein, procedure adopted by the author for the collection, mounting and preparation of the material for their final microscopic examinations and detailed studies are given. Tabulation of data for studying the correlation and regression of population buildup with weather parameters and techniques adopted for study of biology forms the subject matter of this chapter.

The fourth chapter comprises of a general morphology of the family Pyralidae to acquaint with the various terminology used in the descriptions, laying more stress on those of taxonomic importance, illustrating the same with suitable diagrams.

The fifth chapter is devoted to the classification and taxonomic studies of 25 species belonging to 16 genera under 5 subfamilies. Keys to all the examined subfamilies, genera and species are given, which are followed by their diagnostic

characters including external features, neurations of fore and hind wings, male and female genitalia, length, wing span, distribution, and material examined for each species. The wing venation, legs, genitalia of male and female, of all the species are illustrated. Coloured photographs of male and female adults of all the 25 species (except *Scirpophaga fusciflua*, only female) and their enlarged head showing labial palpi and eyes are given.

A taxonomic discussion on the various taxa used in the thesis are presented in the sixth chapter. Some suggestions regarding nomenclature and characterization of few species have also been included for the sake of future workers.

In the seventh chapter on the biology and effect of weather factors (maximum and minimum temperature, rainfall, relative humidity at morning, relative humidity at evening and sunshine hours) on the population buildup of rice leaf folder, *C. medinalis* (Guenee) through light trap and net collection under the agroclimatic conditions of Delhi are given.

A female laid 68-94 eggs (average 80.9 eggs) in its life time. Incubation period was 7-9 days (average 6 days), larval period 19-27 days (average 23 days), pupal period 6-8 days (average 7.8 days), adults live, male 2.0-4.0 days (average 3 days) and female 6.0- 9.0 days (average 7.5 days). The total life cycle occupied, male 33.0-48.0 days (average 40.5 days) and female 37.0-53.0 days (average 45.0 days).

The higher moth numbers were trapped in the month of October, exhibiting the peak activity in the first week, followed by September, while the trap catches begun in the first week of June, when the crop was in nursery stage, during this time the trapped moths numbers were very low.

The correlation studies between light trap and net sweep collection with weather parameters on population buildup were carried out. Among the weather parameters, maximum temperature minimum temperature and relative humidity at morning are highly significant ($P < 0.01$). Maximum temperature and minimum temperature have negative impact on the population buildup. However the relative humidity at morning has a positive impact. Thus the low temperature and high relative humidity at morning are favorable for population buildup. The correlation between net sweep collection and light trap collection is very high (0.866), showing that either one of them is enough to monitor the leaf folder population in the field conditions. Both the intercept term and the regression cofficient are highly significant. Thus this can be used as a formula to estimate light trap collection based on the net sweep collection or vice-versa. The dry period and longer sunshine hours, and light rains with two or three cloudy days, and sudden drop in the day and night temperature appear to trigger their peak activity, during October to November.

The studies on the per cent damaged leaves and larval population in relation to weather factors and stage of crop for four years (1997-2000) revealed that the per cent damaged leaves and larval population ranged between 0.5-44.0 and 0.1-10.6, respectively. The per cent damaged leaves and larval population maintained a low key during first two months, July and August, which ranged between 0.5-6.0 and 0.1-2.8, respectively, except during fourth week of August, the per cent damaged leaves and larval population were 12.0 and 2.8, respectively. The peak activity was exhibited during the last week of October, when per cent damaged and larval population were 44.0 and 10.6, respectively.

The correlation studies between larval population and per cent damage, with weather parameters were shows that, the sunshine hours (larval population + 0.379424) and (per cent damage + 0.346180) are highly significant ($p < .001$). While maximum temperature (-0.458814 larval population, -0.555814per cent damaged leaves, rainfall (-0.341316 larval population, -0.329902per cent damage) and relative humidity at evening (-0.514448 larval population, -0.538198 per cent damage) have highly negative impact on larval population and per cent damage, whereas relative humidity at morning is not influencing the larval population and per cent damage.

The correlation between larval population and per cent damage is very high (0.965927). This shows that both (larval population and per cent damage) are influencing each other. Whereas in case of weather parameters, low temperature, low rain fall and low relative humidity are favorable for high larval population buildup as well as high per cent damage, while long day (sunshine hours) are responsible for larval population buildup and high infestation. In both the intercept term and regression coefficient, the larval population is highly significant. This relationship can also be used to quantify the per cent damage leaves, based on larval population. The relationship could be useful in rice growth models as the effect of leaf folder larval population. In the step-wise regression model, only maximum and minimum temperature were included. However, the t-test for regression coefficients are not significant for both minimum and maximum temperature. The intercept was highly significant. The model may be used to predict the larval population based on temperature. The R^2 is low, hence the model may not be stable. Further studies with more number of years are required to build a more stable prediction model.

Studies on the effect of weather factors on the larval and pupal parasitization of leaf folder, *Cnaphalocrocis medinalis* (Guenee), revealed these ranged between 7.25-33.5 per cent and 10-50 per cent, respectively. The peak parasitization was observed during third and fourth week of September, and ranged between 24.5-33.5 per cent larvae and 10.0-50.0 per cent pupae, at about 60-85 days after transplanting. The correlation studies between larval and pupal parasitization, in relation to weather factors, among the weather factors, sunshine hours (+0.411626 larvae and +0.361075 pupae) are highly significant ($P< 0.01$). The rainfall (-0.264729 pupae) have negative impact on parasitization. However, the rainfall (-0.183981 larvae) and maximum temperature (-0.183324 pupae) are also significant at 5 per cent level of significance. The correlation between larval and pupal parasitization is very high (0.813990). This showed that either one of them is enough to monitor the parasitoids activity in field conditions. In both the intercept term and regression coefficient, the larval parasitization is highly significant, while in case of pupal parasitization, it is significant at 5 per cent level of significance.

In the last chapter all the 322 references (with complete title, name of journal, volume and page number etc.) mentioned in the text is given.

Two appendixes append the thesis. The first one is a checklist of genera and species examined and second one is with all the informations about types (including type localities, sex and number of type specimens and type location with certain remarks) of valid species and their synonymies.

Finally the thesis contained 27 plates with 337 figures and 12 tables.


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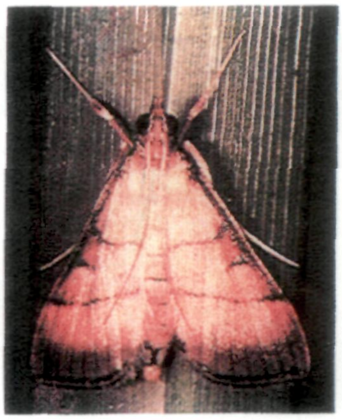

THESIS

Submitted in Partial Fulfilment of the Requirements for the Award of the Degree of

DOCTOR OF PHILOSOPHY

IN

AGRICULTURE
(ENTOMOLOGY)


BY

ZAKIR HUSAIN KHAN

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2000




DEDICATED

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CERTIFICATE

This is to certify that the thesis entitled "**Biosystematic studies on pyralid pests of rice crop in India (Pyralidae: Lepidoptera)**" submitted to the Aligarh Muslim University, Aligarh in partial fulfillment of the requirement for the award of the degree of Doctor of Philosophy in Agriculture Entomology is based on the results of the bonafied research work carried out by **MR. ZAKIR HUSAIN KHAN** under my co-supervision and guidance. No part of this thesis has been submitted for any other degree or diploma.

I further certify that he, as has been availed of in this thesis, dully acknowledges such help or information.

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This is to certify that Mr. Zakir Husain Khan has completed his Ph.D. work under my supervision on the problem entitled "Biosystematic studies on pyralid pests of rice crop in India (Pyralidae: Lepidoptera)". The work is an original contribution and distinct addition to the existing knowledge on the subject. Being satisfied with quality and quantity of work. He is permitted to submit the thesis for the award of Ph.D. degree in Agricultural Entomology of the Aligarh Muslim University, Aligarh.

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ACKNOWLEDGEMENT

I express my grateful thanks to Dr. S. L. Gupta, Senior Scientist, Division of Entomology, Indian Agricultural Research Institute, New Delhi (Co-supervisor) and **Prof. Absar Mustafa Khan,** Department of Zoology, Aligarh Muslim University, Aligarh (Supervisor), for their guidance, valuable suggestions and constant encouragement during the entire research work.

I am grateful to Prof. N. Ramakrishanan, Ex Head, Division of Entomology, IARI, New Delhi; Dr. Zaka-ur-Rab, Ex Director, Institute of Agriculture, AMU, Aligarh, to allow me to work at IARI, New Delhi; Dr. V. K. Sehgal, present Head of the Division of Entomology, IARI, New Delhi and Prof. Akhtar Haseeb,Chairman, Department of Plant Protection, AMU, Aligarh for providing facility and permission to work.

I owe special sense of gratitude to Dr. V. V. Ramamurthy, Sr. Scientist, Division of Entomology, IARI, New Delhi for their encouragement, moral support and for critically going through the manuscript and giving valuable suggestions. Thanks are also due to Dr. Dhandha Pani (Scientist), NCIPM, New Delhi, for statistical analysis.

I find no words adequate to express my sincere thanks and deep sense of gratitude to Dr. S. I. Farooqi (Rtd. Principal Scientist), Division of Entomology, IARI, New Delhi, Dr. G. S. Arora (Rtd. Scientist), ZSI, Kolkata, for their valuable suggestions and constant encouragement throughout the work.

I extend my thanks to Dr. (Mrs.) Usha Ramakrishanan (Rtd. Principal Scientist), Dr. (Mrs) D. Dey, Mrs. Asha Gaur, Dr. (Mrs) Sushila Joshi, S/Shri Mayank, Mohan, Raghu, Ram Kumar, Mumtaz and B. Prasad, all of systematic section, Division of Entomology, IARI, New Delhi for their kind co-operation.

I am also thankful to Drs. K.H. Siddiqui, S. Chaudhary, A. K. Garg, Prem Kishore, S. Chandra and (Mrs.) C.M. Anand for their constant encouragement and valuable suggestions and moral support throughout the work.

Thanks are due to Dr. M. Shaffer, British Museum (Natural History), London, for his help regarding literature and some current information related to the present research work.

I am also grateful to my teachers Prof. Humayun Murad, Prof. M. Hayat and Prof. Shujauddin, Department of Zoology and to Drs. P. Q. Rizvi, Shafiq Ansari, Shabbir Asharaf, Mujeeb and all the teaching and non teaching staff of Faculty of Agriculture, AMU, Aligarh for their encouragement.

I express my sincere thanks to my friends Dr. Niamat, Israr, Pradeep, Abrar, Arshad, Zubair, Sami and my well wishers Mr. and Mrs. Dr. Farooq, Dr. (Mrs.) Shama Afroz, S/Shri Afzal, Musharraf Ali Khan, Manzar, Shafi, Sohrab, Ghayas, Mahesh, Arvind, Anand, Haris, Aslam, Rashid, and several other friends whose names could not be included here.

I am also thankful to Ms Kamini for typing the manuscript, Mr. Jafri for making table and graphs, S/Shri Aditya Pundir, Vikkrant Pundir, Manu, Kulbhushan, Prashant Tyagi for scanning of photographs and making attractive plates.

I am grateful to the Indian Council of Agricultural Research, New Delhi for financial support through AP Cess Fund Project.

Last but not the least thanks are due to my parents, younger brothers, Mr. Naseem and Mr. Sleem and sister Rafat Rehana and other family members for their co-operation, encouragement and moral support.

(ZAKIR HUSAIN KHAN)

CONTENTS

CHAPTER-1

INTRODUCTION

INTRODUCTION

Rice is primarily staple food for more than 2 billion people in Asia and for hundreds of million people in Africa and Latin America (Anonymous, 1985). Among the major food crops, rice is the only one that is almost exclusively a human food. It constitutes half of the diet of more than 1.6 billion people and four hundred millions rely on rice for one fourths to half of their diet (Swaminathan, 1984). Consumption per capita varies from 186 kg/year in Myanmar to as low as 4 kg/ year in USA (Anonymous, 1988). It is grown world wide in over 150 million hectares and the production is 562 million tonnes, at an average yield of 3.37 tones per hectare. But in India though rice is cultivated in 42.7 million hectares, but production is only 85 million tonnes, amounting to an average as low as 1.9 tonnes per hectare. Even in those pockets of rice producing areas where peaks has been achieved, average yield is dwindling year after year. This gradual reduction in productivity, inspite of improved inputs like high yielding varieties, high doses of fertilizers and pesticides etc., has been often attributed to change in soil fertility status and it is an imminent threat to sustainability in rice production.

It is estimated that by 2020 the population of India will increase to 130 million, requiring 325 million tonnes of food grain; at the present trend, estimated requirement of rice by 2001-2002 and 2006- 2007 will be around 94 and 103 million tonnes, respectively. However, our food production in India is very low in comparison to the world, stagnating around 190-200 million tonnes, since last five years; pace of growth is very low, and in rice the growth rate is merely 1 per cent during the last decade. One of the major constraints in rice production in India especially in the southern, central and eastern parts is the occurrence of pests and diseases at serious levels. Intensive and extensive cultivation of rice for maximization of yield and use of new strategies in agriculture has led to complete change over in the ecology of rice field and because of the changed agro-ecosystem, some cutworms and army worms have become major pests nowadays.

More than 825 insect species are reported as a pests of rice all over the world of which 300 are reported from India alone. The lepidopterous insects like stem borers, leaf folders, army worms and cutworms constitute major proportion of the pest complex of rice. There are 101 species belonging to 14 different families namely Pyralidae, Noctuidae, Hesperiidae, Lymantriidae, Arctiidae, Pieridae, Nymphalidae, Satyridae, Eupterotidae, Notodontidae, Gelechiidae, Limacodidae, Lasiocampidae and Psychididae (Khan *et al.,* 1999). It has been observed that species of the family Pyralidae are the most destructive of all lepidopterous due to mejorty of them being stem borers and leaf folders; on an average it has been estimated that 20-30 per cent of rice yield is low due to these pests alone.

The adult pyralid moths are delicates, easily recognizable by their thin slender body and wing venation. Well developed proboscis, maxillary palpi and frenulum hooks are the distinguishing characters and their labial palpi are often much projecting; fore wings are elongate and triangular with vein 1^{st} A absent, but sometimes present in the terminal front (sub family Schoenobinae); Vein 2^{nd} A well developed and free; vein 3^{rd} A present near the base, curved upward and joining the 2^{nd} A, forming a fork; vein M_2 arising from lower angle of cell; veins R_3 and R_4 always stalked; hind wing with vein M_2 usually from near lower angle of cell, veins $Sc+R_1$ approximated to Rs or anastomosing with it beyond the cell, veins 1^{st} A, 2^{nd}A and 3^{rd} A present.

These are widely distributed, destructive and usually exhibit a high degree of host plant specificity. Some of them are stem borers, others are leaf folder and case worms; rice stem borers constitute the economically important group and in India, predominant and widely distributed rice stem borers are yellow stem borer *Scirpophaga incertulas* (Walker), pale-headed striped borer *Chilo suppressalis* (Walker) and dark headed stem borer *Chilotraea polychrysa* (Meyrick); other species such as *Chilotraea auricilia* (Dudgeon), *C. infuscatellus* (Snellen), *Chilo partellus* (Swinhoe), *Scirpophaga nivella* (Fabricius), *S. fusciflua* Hampson, *Borer sacchariphagus indicus* (Kapur) and *Saluria inficita* Walker are restricted localized in their distributions; some like *Ancylolomia chrysographella* (Kollar), *Scirpophaga* *gilviberbis* Zeller and *Maliarpha separatella* Ragonot are rarely reported to infest rice in India.

The rice leaf folder complex previously considered as a minor pest, of late has gained major pest status and its prominence has been well documented in the bibliography by Joshi *et al.*, (1983), Khan *et al.*, (1988; 1991; 1999), Moore (1986). Contrary to the earlier knowledge that *Cnaphalocrocis medinalis* (Guenee) is the only rice leaf folder, these are twelve species of Pyralidae i.e., *Cnaphalocrocis medinalis* (Gunee), *C. exigua* (Butler), *C. bilinealis* (Hampson), *C. patnalis* (Bradley), *C. suspicalis* (Walker), *C. poeyalis* (Biosduval), *Pleuroptya balteata* (Fabricius), *Notarcha obrinusalis* (Walker), *Crypsiptya coclesalis* (Walker), *Herpetogramma licarsisalis* (Walker) and *H. phoeopteralis* (Guenee) which now comprise the leaf folder complex these are reported from various rice growing areas of India, only *Cnaphalocrocis medinalis* (Guenee) and *C. exigua* (Butler) are reported cause serious damage.

The rice case worm, *Parapoynx stagnalis* (Zeller) is another important pyralid in the vegetative stage; usually its population is low when there is standing water; and is more prevalent in rainy season, pest found in the irrigated and rainfed wet land environments. sometimes there is sudden increase in their number causing serious damage (Joseph, 1969). Infestation is more severe in dwarf, compact, heavy tillering and high yielding varieties. In India *P. fluctuosalis* (Zeller) is aslo found along with.

Inspite of such a great importance, proper identity of its species and nomenclature are still shrouded with much confusion, which is evident from the publications of Shaffer *et al.*, (1996) and Arora and Gupta (1999). Hampson (1896) classified this group on the basis of wing venation, size and shape of labial palpi, maxillary palpi, shape of frons and general colour. No consideration was made for intrageneric and intraspecific variations or aberrations, with the result there has been so many synonymies and homonymies. Janse (1935) remarked that the study of Pyralidae afford considerable difficulties because the description of genera and species are too vague to give any degree of certainty and he was particularly critical of Hampson (1896). In studying over 100 species placed by Hampson in the genus *Margaronia* Huebner, he found only 50 per cent of the species having labial palpi as characteristic of the genus. He apprehensive that the classification based on labial palpi would ultimately require a revision. Tams (1942) pointed out that genus *Diatraea* Guilding is a new world genus and the Indian species named after *Diatraea* had to be changed. Kapur (1950) working on crambine moths associated with sugarcane in India found it necessary to erect four new genera and six new species.

Common (1960) transferred two popular Indian species i.e., *Schoenobius incertulas* Walker and *Scirpophaga nivella* (Fabricius) to his new genus *Tryporyza*. Bleszynski (1962) made a substantial contribution on nomenclature and published a short catalogue of the world species of family Crambidae and also made a critical comment on the Kapur's popular genus *Chilotraea*. According to him there is no justification for erecting a new genus on the basis of shape of frons and coincidence of veins Sc and R_1 of fore wing. Kapur (1967) did the taxonomic studies on rice stem borers in which he included 18 species of Pyralidae (Crambinae 11, Schoenobiinae 5 and Phycitinae 2) and 3 species of family Noctuidae.

Lewvanich (1981) revised the world species of genus *Scirpophaga* Treitschke, in which he provided taxonomic history of the genus, host plants of the various species, zoogeography of the genera, key to the species and proposed several new synonymies, the most important being the synonymization of *Tryporyza* Common with that of *Scirpophaga* Treitschke. Schaffer *et al.*, (1996) prepared a check list of Australian Pyralidae, in which several new synonymies of the genera and species and these include number of genera and species infesting rice in India. Excepting for few isolated works (Rose, 1983; Rose and Dhillon, 1982; Rose and Pajni,1986; Mathew and Menon,1985; 1986;, Ghai *et al.*, 1979; Gupta, 1991; 1994 and Arora and Gupta, 1999; and Arora, 2000), there is no comprehensive attempt on the taxonomy of this group of insects associated with rice.

The perusal of literature had indicated that in addition to extensive studies, explaned above, there are gaps in the knowledge of biodiversity of Lepidoptera especially Pyralidae associated with rice. In particular information is lacking on the biology and ecology of rice leaf folder, *C. medinalis* which is emerging as a serious pest in the Basmati varieties grown in the northern belt. This insect was first reported as rice pest by Lefroy (1909), hitherto considered as minor pest of rice (Fletcher, 1914, 1917; Misra, 1920; Ballard, 1921; Ayyar, 1932; Usman and Puttaruddriah, 1955; Reddy, 1968 and Vevai, 1968). Has of late assumed the status the major pest in all over the country and cause serious damage in most of the rice growing tract of India (Malik *at al.,* 1985). Kulshrestha (1973) estimated the yield loss upto 50% by this pest.

Hence the objectives of the present study are:

1. to undertake survey on Pyralidae associated with rice;
2. to study the taxonomy of Pyralidae;
3. to comprehend the information already available, with the results of the present study;
4. to prepare diagnostic keys with suitable illustrations;
5. to prepare a checklist with all details about types of Pyralidae associated with rice;
6. to study bionomics of rice leaf folder, *C. medinalis* (Guenee);
7. to study effect of weather factors on population buildup of rice leaf folder, *C. medinalis* (Guenee);
8. to study effect of weather factors on activity of larval and pupal parasitoids of rice leaf folder, *C. medinalis* (Guenee).

CHAPTER-2

REVIEW

OF

LITERATURE

REVIEW OF LITERATURE

TAXONOMY OF SUPRA GENERIC TAXAS

The nomenclature of the family has gone through a number of changes. Linnaeus (1758) first of all named it as Pyrales. Since then they were named variously as Pyralides (Schiffermueller and Dennis, 1776), Pyralidae (Stephens, 1829), Crambides and Pyralidides (Herrich-Schaeffer, 1848), Pyralidoidea (Herrich-Schaeffer, 1852), Pyralites (Guenee, 1854), Pyralidina (Stainton, 1858), Pyralides (Walker, 1859[a]) and Pyralidina (Ragonot, 1890). Hampson (1896) followed Stephens (1829) and named it as Pyralidae, and he divided it into 12 subfamilies namely Anerastiinae, Chrysauginae, Crambinae, Endotrichinae, Epipaschinae, Galleriinae, Hydrocampinae, Phycitinae, Pyralinae, Pyraustinae, Schoenobiinae and Scopariinae. This classification was maintained by Hampson (1898).

Comstock (1950) divided this family into six subfamilies i.e. Crambinae, Galleriinae, Nymphulinae, Phycitinae, Pyralidinae and Pyraustinae. Zimmerman (1958) removed the *scoparin* moths from Pyraustinae and put them under a separate subfamily Scopariinae. Imms (1925) combined the subfamilies Pyraustinae, Schoenobiinae, Hydrocampinae and Scopariinae under Pyraustidae, Phycitinae and Anerastiinae under Phycitidae and Pyralinae, Chrysauginae, Endotrichinae and Epipaschiinae under family Pyralidae. Shibuya (1928-29) considered it as a family and divided it into 11 subfamilies.

Pruthi (1969) revised Pyraustidae and created one more family Schoenobiidae. Afterwards most of the entomologists like Borer and Delong (1970) and Richard and Davis in Imms (1977) treated the various families of Imms (1925) as subfamilies. Shaffer *et al.*, (1996) recognized 19 subfamilies under the family Pyralidae.

TAXONOMY OF LOWER TAXAS

The early history of work on Indian Pyralidae can be traced through the publications of workers like Linnaeus (1758), Fabricius (1792-1798), Huebner (1818, 1823, 1825, 1816-27), Kollar (1848), Duponchel (1831, 1845), Treitschke (1832) and

Zeller (1839, 1877). However, the first actual record of Indian Pyralidae was by Guenee (1854) who described 42 new species from different parts of India. His collection was deposited at the Natural History Museum, Paris and British Museum (Natural History), (Natural History Museum) London. The work of Guenee was followed by Walker (1859[a], 1859[b], 1859[c], 1863[d], 1863[b] and 1865) who published a list of the pyralid species available at the British Museum (Natural History), London and described a number of new genera and new species from all over the world, including India.

Moore (1865) published a list of the pyralid species from Bengal and described 3 new genera and 13 new species. Again he (1872) enumerated the pyralids of western and southern India. Subsequently in 1877, he gave an exhaustive account of the pyralid moths of South Andaman and Nicobar Islands. Butler (1877[a]) described a new species *Chilo simplex* from India. Further he (1879) gave an account of the pyralid moths collected by William Grant from North East Indies. Swinhoe (1884) described 5 new species from Karachi which include *Crambus zonellus,* now considered to be a synonym of *Chilo partellus* (Swinhoe). In 1885, he worked on the Lepidopetra fauna of Bombay and Deccan and described 2 new genera and 22 new species, including *Crambus partellus.*

Moore (1884-87) published 3 volumes of Lepidopetra of Sri Lanka, of which the third contain, many new genera and new species of pyralids occurring in India also. Again in 1888, he described number of new species from India, which included several pyralids. Warren (1888) published a list of Lepidopetra collected by Major Yerbury from Western India, which included 4 new species of pyralids. Swinhoe (1889) described one new genera and 10 new species from different parts of the country. Snellen (1890[a]) made a detailed catalogue of the pyralid fauna of Sikkim which included 86 genera and 253 species, of which 43 were new to science. He also suggested number of nomenclatural changes. Hampson (1891) did an extensive collection of about 1000 species from Nilgiris in which there were many new species.

Warren (1892) described number of new genera under this family out of the collection available in British Museum (Natural History), London. Swinhoe (1892) described 4 new species and a new subspeicies from Khasi Hills. Further in 1894, he described 7 new genera and 45 new species from the same locality. Warren (1896[b]) made a detailed study of the pyralid fauna of Khasi Hills and described 6 new genera and 35 new species. At the same time, Hampson (1896) published *Fauna of British India Moths* Vol. IV which dealt with Pyralidae. This include taxonomic studies on 1035 species placed in 238 genera including large number of synonymies. Later on, he (1898, 1899) revised the subfamily Pyraustinae of family Pyralidae.

Swinhoe (1900) prepared a synonymic catalogue of the Eastern and Australian Lepidoptera, Heterocera available in the collection of Oxford Museum, which included several pyralid species along with information on type specimens. Hampson (1903) added many genera and species to all the subfamilies of Pyralidae. Swinhoe (1906, 1907) described some more new pyralids from Khasi Hills and Andaman and Nicobar Islands, respectively. Hampson (1908, 1912) described many new genera and new species of pyralids and proposed several nomenclatural changes. Again, he (1917, 1918[a], 1918[b], 1918[c], 1919[a], 1919[b]) described many new genera and new species of subfamily Pyralidae from different parts of India.

Fletcher (1919) prepared an annotated list of the Indian crop pests which include number of pyralids. Fletcher and Ghosh (1919) provided informations pertaining to borers in sugarcane, rice etc. Fletcher (1928) described a new species *Chilo oryzae* infesting rice from India. Shibuya (1928-29) published a monograph on the systematics of pyralids which include several pyralids found in India also. This contains key to species, complete synonymies of genera and species along with their general and local distributions in Taiwan.

Klima (1936, 1939) prepared a world catalogue of the subfamily Pyraustinae. Sevastopulo (1948) listed food plants of some Indian Pyralidae. Kapur (1950) prepared a comprehensive paper on some Crambinae associated with sugarcane in India where he described 4 new genera and 6 new species. Martin (1959) published a note on some rice stem borers of family Pyralidae and proposed two new synonymies of *Maliarpha separatella* Ragnot. Common (1960) revised the Australian stem borers of the genera *Scirpophaga* Treitschke and *Schoenobius* Duponchel and described 3 new genera and number of new species. Nazmi (1963) provided redescriptions of the Pyraustinae of Egypt, which include a number of species with detail description of wing venation and male and female genitalia. Grist and Lever (1969) published a book on pests of rice throughout the world. Agarwal and Tiwari (1969) illustrated and described the male and female genitalia of *Scirpophaga nivella* (Fabricius), *Chilotraea infuscatellus* (Snellen), *C. auricilius* (Dudgeon), *Chilo zonellus* (Swinhoe) and *Proceras indicus* Kapur.

Kapur (1967) did the taxonomic studies on rice stem borers which included 6 genera and 11 species under Crambinae, 3 genera and 5 species under Schoenobiinae and 2 genera and 2 species under Phycitinae. This contained key to genera, several references on genera and species, their common names, distributions, host range and remarks. He illustrated the male and female genetalia of *Chilo suppressalis* (Walker), *Tryporyza incertulas* (Walker) and *T. innotata* (Walker) in detail.

Rao *et Al.,* (1969) published a paper on leaf feeding caterpillars of rice and their natural enemies in India. Sen and Chakravarty (1970) reported 2 new leaf rollers of rice plant in India. Talgeri *et al.,* (1970) studied the status of different stem borers of rice in the state of Maharashtra. Bleszynski (1970) revised the world species of genus *Chilo* Zincken. He transferred number of species of *Chilo* Zincken to other genera and even sometimes to other subfamilies. He provided synonymic catalogue of all the species known till then and described several new species. He also prepared a key to the different species based on shape of face, wing colourations, wing venation and genitalia. He gave an account of the type specimens of most of the species and designated number of lectotypes and paralectotypes. He recorded the zoogeographical distributions of all the species, known so far.

Munroe (1972-76) has made a study on Nymphulinae and given a generalised genitalia features of both male and female with a detailed discussion about the different parts. He also discussed about the tribes, to which genus *Parapoynx* belongs, on the basis of wing characters and considered two more tribes viz; Argyractiini and Ambiini. Hill (1975) published a book on agricultural insect pests of the tropics and their control which included several pyralids from India. Ghai *et al.,* (1979) compiled a list of lepdopterous insects associated with rice crop in India, in which synonymies/misidentification, distributions, alternate hosts, distinguishing characters of the species and taxonomic remarks on some of the confusing species were given.

Lewvanich (1981) revised the old world species of genus *Scirpophaga* Treitschke which include 35 species. One genus and 12 species were newly placed as synonymies, and ten species were transferred to genus *Scirpophaga* Treitschke from other genera; five species were described as new to science. He also prepared keys to identify different species on the basis of wing venation and genitalia, and details about the type specimens was also provided. All the species were provided with a taxonomic account. Barrion and Litsinger (1981) suggested some nomenclatural changes for some rice pests and also discussed the taxonomic position of *Scirpophaga incertulas* (Walker). Agassiz (1981) provided diagnostic characters of *Parapoynx fluctuosalis* (Zeller) and *P. stagnalis* (Zeller).

Rose (1982) studied the male genetalia of 23 species of Indian Pyraustinae and discussed their taxonomic significance. Further, Rose and Dhillon in the same year studied the female genitalia of 25 species of Indian Pyraustinae. Wang and Sung (1982) provided diagnostic characters of *Ancylolomia chrysographella* (Kollar) infesting rice crop in China. Mathew and Menon (1984) prepared a list of 155 species of pyralids collected from different parts of Kerala. Further, the same authors in 1985 studied the male and female genitalia of 13 species of Indian pyralids. Again in 1986, they published a paper on the identities of some leaf rollers belonging to genera *Bradina* Lederer, *Marasima* Lederer and *Cnaphalocrois* Lederer and also described their male and female genetalia. Ahmed (1986) studied on the rice insects of Pakistan with reference to their systematics. Rose and Pajni in the same year studied the male and female genetalia of 12 species of subfamily Nymphulinae from North India.

Barrion *et al.*, (1991) made a detailed study of *Cnaphalacrocis medinalis* (Guenee) from Philippines which included population dynamics, biology and taxonomy. Gupta (1991) prepared a dichotomous key for the identities of 59 species of Lepidopetra associated with rice crop in India. Kamaluddin and Ahmed (1993) redescribed the sorghum and rice stem borer *Chilo partellus* (Swinhoe), with special reference to its genitalic studies, geographical distribution, biology, nature of damage and control strategies. Heinrich (1994) published a book entitled "Biology and Management of rice insects" where he provided and illustrated key to identify lepidopterous insects in addition to their general distributions, alternate host plants, biology, seasonal prevalance, nature of damage and control strategies. Gupta (1994) published a checklist of Indian Pyraustinae which include synonymies of the genera and species, type localities, sex and number of type specimens, type locations and their distribution in India.

Shaffer *et al.*, (1996) prepared a checklist of Australian Pyralidae where he proposed number of new combinations and several new synonymies of genera and species. This included number of genera and species distributed in India too. Cook (1997) revised the genus *Maliarpha* Ragonot based on adult morphology and described 3 new species, and revised *M. separatella* Ragonot.

Prakash and Rao (1998) published a book where they provided descriptions for number of pyralid pests of rice crop, their distribution, alternate hosts, biology, nature of damage, forecasting and control strategies.

Khan *et al.*, (1999) made an inventory of the biodiversity of lepidopterous insects associated with rice agroecosystems including important biological details namley distribution, part of plants attacked, symptoms and damage, bionomics, alternate host plants and literature leading to other details, especially on their taxonomy and management. This study indicated indicated that the pyralids are most potential rice pests which need to be given special emphasis, and monitored seriously for effective IPM in rice agro-ecosystems. Arora and Gupta (1999) revalidated the genus *Chilotraea* Kapur. Further in the same year Gupta recorded *Chilotrea ceylonicus* (Hampson) for the first time from India. Arora (2000) did biosystematic studies on 44 species spread over 27 genera of family Pyralidae, which are economically important.

BIOLOGY AND ECOLOGY OF RICE LEAF FOLDER, *CNAPHALOCROCIS MEDINALIS* (GUENEE)

BIOLOGY

Preliminary details on biology of rice leaf folder, *Cnaphalocrocis medinalis* was given by Fletcher (1914, 1917) and Alam and Alam (1964); but later the detailed studies were made by Abraham (1958), Lingappa (1972) and Yadava et al., (1972).

These reports conclude that on an average of 100 +25 eggs are laid by a single female, and the incubation and larval periods are 6-7 and 15-17 days, respectively; total life cycle lasted for 30 to 44 days. Velusamy and Subramaniam (1974) reported five larval instars, and concluded that the development from egg to adult was completed on an average of 35.23 days under laboratory conditions. Godase and Dumbre (1982) mentioned that the total life cycle ranged from 30-44 days with a mean of 35.89 days; a female laid 89+13.5 eggs, incubation period averaged 6.89 days; larvae passed through five instars. in 15-17 days; and pre-pupal and pupal periods averaged 1.85 and 6.35 days, respectively.

Abenes and Khan (1990) reported significantly high larval survival growth index and pupal weight on susceptible 1R-36 rice variety than the resistant TKM-6.

Prasad *et al*. (1993) studied its biology under the agroclimatic conditions of Ranchi. These results concluded that female laid on an average 56 eggs; incubation, larval and pupal periods were 4 to 5, 25 to 26 and 7 to 8 days, respectively; total life cycle occupied 37 to 38 days. Gupta *et al.*, (1996[a] and 1996[b]) studied the biology and off season bioactivity in Assam. These workers also made a life table study under laboratory conditions.

MONITORING OF RICE LEAF FOLDER THROUGH LIGHT TRAP

It is an established fact that visible light attracts a wide range of insects. It offers an efficient means of obtaining information regarding the distribution, seasonal flight periods and peak of abundance thereby helping in the suppression of pest through suitable plant protection measures at appropriate time (Hienton, 1974). Rice leaf folder, is known to be nocturnal and the moths are attracted towards artificial light in large numbers (Velusamy and Subramanium, 1974). Mohan and Janarthanan (1985[a]) reported that, the catch patterns could explain emergence and their build up in the crop. Mohan and Janarthanan (1985[b]) found good correlation between light trap catch and field population of rice yellow stem borer. They also observed high incidence of borer in the vicinity of trap. Rao (1985) observed high correlation between light trap catches and field population of rice yellow stem borer in Cuttack. Srivastava and Mathur (1985) *reported similar trend in the field population and light* trap catches of *Nephotettix* sp., and suggested that light trap data could be used conveniently to estimate the insect activity or field behaviour.

Qadeer *et al.*, (1990) carried out investigation to determine the abundance of major insect pest of rice through light trap and the influence of climatic factors. Cumulative rainfall influenced the catch of the insects significantly than any other weather factors. In recent years, the use of light trap is being advocated for the purpose of insect monitoring in order to take up appropriate control measures in the Integrated Pest Management (Loevinsohan, 1991).

Harinkhere *et al.*, (1998) investigated on seasonal abundance of rice leaf folder, during wet season for 8 years at Waraseoni, Madhya Pradesh. The moth catches and field incidence begun in the first week of August and showed significant increasing trend in month of September. The peak period of moths and field incidence was in the month of September followed by October. The significant positive association between light trap catches and field incidence reflected the severity pattern of leaf folders in the field.

Bhatnagar and Saxena, (1999) studied the effect of weather factors on the population build up of rice insect pests through light trap collection at Jagdalpur, over four years. The study revealed that rice leaf folder maintained a low key during the first three months of cropping season. Relatively higher moth numbers were trapped during October, exhibiting their peak activity in the last week. The leaf folder showed significant negative correlation with minimum temperature, evening relative humidity and rainfall, while positive significant correlation was observed with sunshine hours and maximum temperature. Regression equations derived to explain the relationship between the population buildup of pests and different weather parameters were enumerated. In this study Manjunath (1982) and Reddy and Mishra (1983) reported that dry spell and longer sunshine hours, and light rains coupled with cloudy days and sudden drop in the day and night temperature triggered peak activity of pest during October-November. The importance of light trap catches in monitoring pest and natural enemies over the crop season was studied (Anonymous, 1998; 1999). Kaul *et al.*, (1999) studied the seasonal abundance of rice leaf folder in Kangra Valley of Himanhal Pradesh, by sampling larvae and the use of light traps. Monitoring indicated that the peak activity of adults occurred during the fourth week of August and that of the larvae during second week of September.

POPULATION DYNAMICS AND FIELD INFESTATION

Lefroy (1909) reported it for the first time as a pest of rice. Pathak et al., (1968) observed that the high humidity and optimum temperature appeared to be important factors in increasing the population. Chaudhari and Bindra (1970) reported its occurrence in the Kapurthala district of Punjab in 1967 in epizootic proportions, causing considerable losses. Dorge *et al.*, (1971) reported that it is a very minor pest in Maharashtra until it broke out in an epidemic form in the Konkan region. Since then the pest has occurred in same region almost every year causing heavy annual losses. Kulshrestha (1973) estimated that the yield loss up to 50 per cent in severely attacked rice crop. Velusamy *et al.*, (1973) recorded its occurrence in varieties like IR-8, IR-20, Jaya, Padma and Karuna in Tamil Nadu. Later, Velusamy and Subramaniam (1974) observed that relatively more high yielding varieties are prefered and the peak incidence occurred during October, November and April at Coimbatore. Chandragiri *et al.*, (1974) reported higher leaf damage (30.32 per cent) at heavy doses of nitrogenous application, and the same was observed by Subbiah and Muracharan (1974). Hirao (1976) reported that variations in peak incidence was due to change in sowing dates or growing season. Dhaliwal, *et al.*, (1979) reported that the leaf folder infestation increased with the increasing nitrogen levels. Rao *et al.*, (1980) considered that the rice leaf folder is a common pest, causing moderate to severe damage in all the rice growing states of India. It was of minor importance earlier but now, it has assumed the status of a major pest after the introduction of high yielding varieties. Kushwaha and Sharma (1981) reported it as an important pest next to rice root weevil and white backed plant hopper in Haryana. Bautista *et al.*, (1984) estimated that there is 3.2 per cent yield loss per 4.2 per cent damaged leaves per plant. Shen and Lu (1984), revealed that the heaviest yield losses occurred at the early ear forming stage and medium at the milky stage. Similarly, Miyasita (1985) observed that there is no yield loss at the grain filling stage, although 67 per cent leaves were injured; however, when damage occurred at heading stage, yield was reduced due to reduction in percentage of ripened grains.

In a study in which fifty eight promising rice cultivars were screened against leaffolder, it was reported that the lowest incidence was 5.2-23.5 per cent in fine grained, scented varieties; highest incidence was 11.7-64.4 per cent and 14.7-60.0 per cent in early maturing and medium duration varieties, respectively (Malik *et al.*, 1985). Murty *et al.*, (1985) reported 18.30 per cent damage and recorded that the larvae of leaf folder scraps the chlorophyll leading to impairment of photosynthesis, reduced vigour and in severe cases even death of the clumps. Its damage increased in the recent years with the introduction of high yielding, fertilizer responsive, rice varieties and their continuous cultivation almost throughout the year in the Godavari delta. Rajendran (1985) reported its increased incidence in the high nitrogen applied plots, and attributed the same to succulent crop growth. Arida and Shephard (1986) reported that variations in the peak period of leaf folder incidence was observed due to change in sowing dates and growing seasons of the crop. Ram (1986) observed that the early heavy monsoon rain followed by a long dry spell, and humid weather induced outbreak of *C. medinalis*.

Patel *et al.*, (1987) reported that long dry spell interspersed with cloudy weather adversely affected its natural enemies, promoting its population build up. Patnaik *et al.*, (9187) studied the reaction of 22 medium duration (101-125 days) and 24 medium late duration (126-140 days) rice cultivars to *C. medinalis* in the field; and found that none of the cultivars are free from the leaf folder. According to Qadeer *et al.*, (1988), the varieties PR-106 and Basmati 370 were most affected; they observed peak incidence in mid September when the crop was at panicle emergence stage. Dhaliwal *et al.*, (1988), reported that the incidence of *C. medinalis* on late transplanted rice was found to be higher than on early planted crops.

Leaf folder assumed the role of a regular, major pest in Haryana, with the serious outbreak during drought season of 1987 (Kushwaha, 1988). The reported that the infestation started from first week of August and lasted tillthe first week of October. Peak infestation was during the second week of September, when the crop was at the booting and panicle emergence stage. Nadarajan and Sakaria (1988) reported a high of 90 per cent leaf damage in the first crop, 55 per cent in second crop, following the repeated use of carbofuramn as compared to untreated control.

Panda and Shi (1989), reported 33 larvae/hill from the plots treated with carbofuran as against 20.4 larvae/hill in untreated plots. Shah (1990) reported that 55-92 per cent of the plants were fed by *C. medinalis;* However, significant yield reduction was been reported at 10 per cent damage leaves at Nawagan in Gujarat, and Coimbatore in Tamil Nadu (Anonymous 1989, 1991, 1992) and Kaul in Haryana (Anonymous 1990, 1992).

Chiranjeevi and Rao (1991) studied its population fluctuations at different planting times of some rice varieties in Andhra Pradesh. They noticed that the damage by the pest increased significantly with delayed planting. Sudhkar *et al.*, (1991) screened 24 rice varieties; maximum infestation was observed in mid early (24.73 per cent) medium (18.93 per cent) and late duration (16.01per cent) varieties when compared with extra early (4.49 per cent) and early (8.97per cent) varieties. Kotwal and Makhmoor (1991) reported its outbreak during the *Kharif* 1989 in Jammu region of Jammu and Kashmir; greatest damage was recorded in CV MRV and the lowest in CV-IET-10319.

Suresh *et al.*, (1991) investigated the combined effects of nitrogen, planting time, stage of crop growth and varieties on the incidence of the leaf folder; maximum infestation of 14.18 per cent was observed in delayed planting, in second stage of crop growth. Douressamy *et al.*, (1992) reported severe outbreak of three species of pyralids including *C. medinalis* during 1989-90 in rice fields of Pondichery and Tamil Nadu, whereas Sachan (1992) reported an outbreak in the monsoon period; in valleys of Uttar Pradesh, this pest appeared in July-October 1991, peak population recorded early August to late September; leaf damage averaged between 45 and 86 per cent and high yielding varieties suffered more damage than local tall ones. Sudhakar *et al.*, (1993) studied the effect of nitrogen on the incidence of leaf folder, *Cnaphalocrocis medinalis* in different varieties, and observed that, at 60 days after transplanting, the damage were 12.19per cent and 25.01 per cent in the least susceptible and the most susceptible, respectively.

Pandya *et al.,* (1994) studied the extent of losses in Southern Gujarat; thus revealed that every unit per cent increase in the pest incidence at tillering, early earing and milky seed stage led to 1.98, 2.22 and 1.12 per cent loss in yield during summer, while 2.18, 2.50 and 1.27 per cent yield loss during wet season, respectively. Prasad *et al.,* (1995[a]) recorded 15.2 per cent leaf damage; continue Prasad *et al.,* (1995[b]) screened 89 cultivars and observed that ranged from 52 to 87.4 per cent and 5.6 to 20.3 per cent in different cultivars, respectively. Singh *et al.,* (1995[a]) reported its occurrence in all the rice growing regions, causing heavy losses. and has determined that the 56.5per cent damaged leaves caused 4080 kg/ha. yields loss of rice, when 10 per cent damaged leaves can safely be considered as a desirable economic threshold. Devanesan *et al.,* (1995) reported 11.17 to 35.45 percent damage to leaves.

Satpal *et al.,* (1995) observed a damage 9 and 67 leaves/ 5 hills at 70 and 80 days after transplanting, respectively. It was also reported that the larval population was 7 and 8 larvae/10 leaves at 70 and 80 days after transplanting, respectively. Kushwaha (1995) reported that Basmati is one of the heavily infested cultivars amounting to 30-80 per cent yield loss, where the infestation conditions extended up to 28.5 per cent leaf damage, with larval population reaching peaks of 20 larvae/ hill. Kumar *et al.,* (1996) studied the population dynamics in relation to stage of the crop and weather factors and the maximum infestation was found during August and September. Ramaraju and Natarajan (1997) reported that the damage was very high ranging from 23.5 to 65.5 per cent folded leaves. While Dash *et al.,* (1997) reported 19.2 per cent damage. Mishra *et al.,* (1997) reported maximum infestation with the September transplanting; and that irrespective of date of planting, the incidence was higher after 7-9 weeks after planting.

Pandi *et al.,* (1998) predicted the damage and yield loss under field condition in Tamil Nadu, and recommended for seeded crop protection at 30 and 40 days after seeding. Kumar *et al.,* (1998) reported that the per cent damage ranged between 7.51 and 50.00 per cent at 30 and 90 days, respectively, after transplanting. Singh and Sharma (1998) observed that the damage leaves ranged between 0.55 to 49.7 per cent and larval population per 10 leaves between 1.66 and 5.5.

Korat *et al.*, (1998) reported an average of 10.35 per cent damage leaves in Gujarat, while Anonymous (1998) reported that the percent damage leaves in different varieties at Nawgam and Coimbatore 10.4- 13.7, at Ludhiana and Meruteru average 12.5 per cent and at Nawgam and Patna average 25 per cent.

Sontak *et al.*, (1999) recorded 17.4 and 14.6 per cent damage on Jaya and Jagati cultivar in summer, respectively. Khan *et al.*, (1999). recorded the maximum damage of leaves up to 28.4 per cent and larval count of 6.6 per hill during 1997 and 17.5 per cent and 3.9 during 1998, respectively, in Pusa Basmati. Anonymous (1999) reported that its incidence was very high at Kapurthala (98.0 per cent) and Ludhiana (94.5 per cent) and low to moderate (5.6 to 5.8 per cent, and 8.7 to 163 average damaged leaves/10 hills) at other centers in Andhra Pradesh, Bihar, Tamil Nadu, Orissa, West Bengal and Uttar Pradesh.

LARVAL PARASITISM

Rao *et al.*, (1969) listed 32 species of larval and eight species of pupal parasitoids. Parasitism averaged about 40 per cent in the farmers fields (Arida and Shepard 1990). The larval parasitism in natural conditions at Aduthurai was at 40, 50 and 60 days after transplanting; 10, 11.3 and 20 per cent, respectively in untreated control plots (Anonymous, 1999). Rao *et al.*, (1970) recorded 45 per cent larval parasitism by *Rhypsipolis hesperids* (Rohwer). Abraham *et al.*, (1973) and Joshi *et al.*, (1987) reported that the 7.4 per cent papae were parasitised by *Brachymeria excarinata* Gahan. Kobayashi and Wada (1979) recorded pupal parasitization 11 per cent by *Nesopimpla naranyae* Ashmead and 34 to 54 per cent paratism larvaal parasitism by *Cremastus biguttulus* Munkata. Pati and Mathur (1982), Chatterjee (1987) reported that the larval parasitism was 21.7 per cent by *Tamelusha philipines* (Ashmead).

Hu and Wu, (1987) and Tian (1987) observed 28.6 per cent larval parasitism by *Apanteles angustibasis* (Gahan). Ahmed *et al.*, (1989) and Rajpakse (1990) reported 5.6 per cent and 4 per cent parasitism by *Pediobus* sp., and *P. bruchicida* (Rondani) respectively. Gordh *et al.*, (1993) recorded 1 to 20 per cent larval parasitism by *Goniozus hanoienis* Gordh. Manisegaran *et al.,* (1997) observed 4-22 per cent and 32 per cent larval pararsitism of by *Elasmus* sp., and *Goniozus* sp., respectively.

CHAPTER-3

MATERIALS

AND

METHODS

MATERIALS AND METHODS

TAXONOMIC STUDIES

The material utilized in the present study was procured from the National Pusa Insect Collection (NPC), Division of Entomology, Indian Agricultural Research Institute, New Delhi. The unidentified collectios available at the NPC could provide 15 species spread over 10 genera. The identified collection at NPC contained 25 species spread over 18 genera.

Besides the above, material was also collected by the author as a result of surveys undertaken to various parts of the country including Thiruvananthapuram (Kerala), Kanyakumari, Madurai, Aduthrai (Tamil Nadu), Hyderabad (Andhra Pradesh), Pantnagar, Nainital (Uttranchal), Karnal (Haryana), Ludhiana (Punjab) and Delhi; material collected as a result of these surveys yielded 4 species under 3 genera.

Since pyralid moths are mostly attracted to light, their collection during night was rather easier. For this Ultraviolet (UV) (Bucket type) light trap was used from time to time. Specimen tubes with a piece of cotton, soaked in benzene, proved quite effective for killing the moths. A piece of blotting paper was placed over cotton so that the moths does not come in direct contact with liquid benzene, and the scales not destroyed. Whenever a moth was seen, the specimen tube was quickly kept over it, the latter was trapped inside the tube and quickly killed without much of wing flattering. Then the moths were transferred to another tube with a slip containing collection data. Later, these moths were stretched and pinned in the laboratory and dried. Entomological pins no. 12. 16, 20 and 100 were used for the purpose of pinning. Enough care was taken to pierce the metathorax gently towards one side so that the under parts are safely preserved. Whenever the specimens were to dry, these were relaxed in a relaxing box for few hours before processing. It was possible to study the gross morphology in pinned specimens but for microscopic examination of the legs, wing venation and genitalia, permanent slides were prepared.

As in other Lepidoptera, wing venation and wing marking are important characters in the taxonomy of the Pyralidae. In most of the specimens, upper surface of wings are heavily covered with scales as compared to the under surface. It was rather easier to study wing venation by keeping the insect with ventral side up under a stereoscopic binocular microscopic. A drop of toluene over wing surface makes the venation further more clear.

For preparation of permanent slides of wings to enable the study of wing venation, several workers like Kapur (1950), Puri (1956) and Eltringham (1960) had suggested different methods. The observations in the present study indicated that the method of Kapur (1950) is satisfactory. Accordingly fore and hind wings of one side were removed carefully from their bases with the help of a forceps and a needle, Then gently placed in a cavity block, containing sufficient quantity of glacial acetic acid mixed with acid fuschin for 12 hours or over night. Thereafter the wings were transferred to another cavity block with carbo-xylol (1 part carbolic acid + 3 parts xylene), and the scales on the wings removed gently with the help of a pencil shaped, rolled paper; then these wings were transferred to a cavity block containing carbo-xylol, to get the veins clear then these ways were mounted on a slide in Canadabalsam and dried enough to get a permanent mount.

For the study of male and female genitalia, abdomen was cut to have at least five terminal segments; whole abdomen was taken wherever the specimens were too small. These removed abdomens were treated with 10% KOH solution for about 12 hrs. to get the musculature sufficiently relaxed and then washed with water; quicker results boiling with 10% KOH was resorted to. Dissection of the genitalia was performed in water within a cavity block, with the help of a fine forceps and needle, under a binocular -stereoscope microscope. The genitalia thus obtained was transferred to glacial acetic acid; at this stage acid fuchsin was used for staining , which proved to be quite effective. After ten minutes, genitalia was again washed with fresh glacial acetic acid to remove the excess stain and then transferred to carbo-xylol. Complete dehyrdation and clearing of the structure was effectively obtained by using glacial acitic acid and carbo-xylol, respectively.

Finally the dissected genitalia were mounted on a micro slide in canadabalsam and covered with coverslips. Permanent slide of legs were prepared after relaxing them in 10% KOH, dehydrating with glacial acetic acid, and then clearing in carbo-xylol.

A micro-projector (Bausch and Lamp) was used for making the illustration of legs, wing venations and genitalia. The legs, wings and genitalia to be drawn was projected on a plain surface at a suitable distance where the desirable magnification was obtained. The details were then drawn on a paper, and stage micrometre was used for drawing the scale.

STUDIES ON BIOLOGY AND ECOLOGYOF LEAF FOLDER, *CNAPHALOCROCIS MEDINALIS* (GUENEE)

BIONOMICS

For the general life cycle studies, leaf folder larvae were collected from the rice fields in the research farm of Indian Agricultural Research Institutes, New Delhi. The larvae were released on potted rice seedlings for rearing to obtain adults for further investigations. The pairs (3 males and 3 females) of newly emerged moths were isolated and confined to separate wooden framed glass cages with of size 60X40X 40 cm. Each cage provided with a 30 days old potted seedlings for oviposition. Observations on number of eggs laid by a female was recorded each day, and freshly laid eggs were transferred along with a portion of leaf to a piece of filter paper seated over moist cotton in a petridish to study incubation period and hatching percentage. Newly hatched larvae were individually transferred to piece of rice leaf placed on moist cotton over a piece of filter paper in a petridish. Fresh leaves were changed once a day until pupation, larval instars studies by observing the moulting. The period for which the adults survived after emergence from pupa was taken as longevity and the preoviposition and oviposition percoids were calculated by observing the begning and end of egg laying.

Observations were undertaken on parasitization by hymenopterous parasitoids during croping season (July-November). For this purpose, larvae and pupae were collected at weekly intervals form rice fields of Indian Agricultural Research Institute, New Delhi. Collected larvae and pupae were separately stored in separate specimen tubes, and larvae provided fresh leaves as food. All these tubes were observed regularly for emergence of parasitoids and then, per cent larvel and pupal parasitization were recorded.

MONITORING OF POPULATION DYNAMICS

Light traps were installed in the rice fields at the research farm of Indian Agricultural Research Insititute, New Delhi during the croping season (June to November 1997-2000). Ultraviolet lamps (8 Wt.) fitted in a bucket type potable of light trap were used for the purpose and observations taken every alternative day by keeping the traps on between 7 p.m. to 5 and 6 a.m. The adults collected were sorted and their population recorded.

Field observations were undertaken on the larval population as well as damage by leaf folder in Pusa Basmati rice cultivar in the farms of Indian Agricultural Research Instuitute, New Delhi during the cropping seasons of 1997-2000. The whole experimental area extending to a 2 hectare area was covered and 10 observational plots, of 1 sq. m. area demarcated randomly at different locations. In each of these observational plots, the incidence and larval population of rice leaf folder was monitored at weekly intervals throughout the cropping season of July to November. In each of these observational plots, randomly four hills were selected and the observations recorded mechanically by hand searching all the tillers. The infested and healthy leaves counted and per cent damage to the leaves were calculated. The infested leaves were opened to record the number of caterpillars for estimation of larvel population per hill. In addition, field observations were undertaken on the adult leaf folders during daytime by using net sweeping twice in a week. Every observation taken by net sweeping was for (twenty sweeps) and number of adults counted. These observations were replicated trice.

The population of leaf folder occuring on rice were monitored for correlation with weather factors.The weahter parameters namely maximum and minimum temperature, morning and evening relative humidity, rainfall and sunshine hours were obtained from the meteorological section, Division of Agricultural Physics, Indian Agricutural Research Institute, New Delhi were used for the purpose. Correlation and regression studies involving the observations obtained on the population by light trap and net sweeping, larval population and percentage damage, and larval and pupal parasitization have undertaken to utilizing the standered statistical procedures available.

CHAPTER-4

GENERAL MORPHOLOGY

GENERAL MORPHOLOGY

Before dealing with the actual taxonomic treatment to various genera and species of the family Pyralidae, it will be worthwhile to understand the general morphology of this group of insects. The details of head, thorax, abdomen and the male and female genitalia of the family Pyralidae are described below, with particular emphasis on the taxonomic characters and the terminology involved in explaining the same (Plate 1 figs. 1, 2).

HEAD

The uppermost region of the head, lying between the dorsal inner margin of the compound eyes, is the vertex which is with ocelli well developed, reduced or completely absent. The occiput occupies the posterior area of head around the occipital foramen. The major frontal area of head is the clypeus, to which the frons is fused, and thus this combined structure is known as fronto-clypeus.

Frons is variable, being smooth, moderately reduced to acute protuberance and with or without corneous point distally. Antennae are characterized by indefinite number of segments and present in the upper region of fronto-clypeus. They are variable, either simple and filiform in both the sexes, or slightly thickened, weakly or strongly serrate, laminate or pectinate in males, and with two rows of scales attached to each segment dorsally, but uniformly pilose, ciliate or fasciculate on underside. In some males, the antennal segments at the base are fused or incised, and bear specialized tuft of scales.

The labrum is very minute and concealed under the anterior margin of fronto-clypeus. It is also very short and triangular with mentum usually obsolete. Labial palpi three segmented, often very long and porrect, giving an appearance of a snout at the front, or moderately long to very short, upturned or porrect or slightly down curved distally, often clothed with short or long scales or even hollowed to receive the maxillary palpi. Maxillary palpi three to four segmented, often dilated with scales at extremity and prominent or reduced to brush like structure, hidden in the hollowed labial palpi.

Proboscis composed of two, greatly elongated galeae, each these is channeled along its inner surface. Galeae are held together by means of hooks and inter-locking spines and form a tube, through which liquid food is imbided. When not in use, it is spirally coiled beneath the thorax. This may be present and prominent. or reduced and rudimentary or completely absent (Plate I, figs. 3, 4, 5, 6, 7, 8).

THORAX

The prothorax is reduced, assuming the form of a collar. It frequently carries a pair of small lateral processes called patagia. The mesothorax is largest and most prominent. Dorsally, it can be distinguished into a narrow band like prescutum, a very large longitudinally divided scutum and a well developed rhomboidal scutellum. Tegulae are developed. The last segment of thorax *i.e.,* metathorax is relatively much smaller, as compared to mesothorax (Plate I, fig. 9).

All the three pairs of legs are generally well developed and its different parts are coxa, trochanter, femur, tibia and tarsi, with the claws and pulvilli. Generally legs are covered with scales and hairs, but the presence of spines on the tibia are of much importance. Fore legs are generally without tibial spurs. Middle legs are generally with one pair of spurs. Hind legs are generally with two pairs of tibial spurs which are very important taxonomically at generic and species level (Plate 2, figs. 10, 11, 12, 13).

The wing membranes are characteristically covered with highly modified and flattened macrotrichia in the form of overlapping scales, which exhibit a wide range of variation in the form and sculptures. Different patterns formed by these scales provide the most important taxonomic characters for identification of various species. The wing membranes are traversed by a system of veins, which are again of great taxonomic value (Plate 2, figs. 16, 17)

Wing venation provides one of the most important and reliable taxonomic character for the identification of pyralids. Fore wing typically has 12 veins and hind wing has 8 veins. The first branch is the costal vein which forms the edge on costa of the wing. Subcostal (Sc) vein (vein 12) comes next which always remains unbranched and runs from the base of wing to costal margin and remain always free from the other veins. This is 12th vein in fore wing and 8th vein in hind wing. Then follows the radial vein which is normally 5 branched (vein 7 to 11 or R_5, R_4 ,R_3, R_2 and R_1) and in hind wing its first branch i.e. 11th or R_1 is fused with Sc (vein 8) called Sc+R_1 and the remaining four branches are completely fused and called as Rs (7th Vein). Next is the median vein which is 3 branched in both wings (vein 4 to 6 or M_3, M_2 and M_1), while cubitus which follows next, is divided into 2 branches called as 3rd and 2nd or Cu_1 and Cu_2. Anal veins are three branched (vein1) or 1st A, 2nd A and 3rd A), out of which vein 1st A is generally absent in fore wing except in subfamily Schoenobiinae, where it is present in the terminal region of fore wing; in hind wing all the three branches of anal veins are present.

The branches of radius, median and cubitus are nearly always united by short cross-veins called discocellular in both the wings at about middle of the wing, leaving an enclosed basal space in the central part of the wing called "cell". The cell is bounded anteriorly by the base of radius and posteriorly by the base of cubitus and the base of median, which traverse the cell, is invariably obliterated.

The fore-and hind wings are held together by frenulum, composed of strong curved bristles arising from the base of the costa of hind wing and fitting into a retinaculum which usually consists of a tuft of hairs arising from the ventral side of the costal vein of fore wing. In males, there is generally a single frenulum, whereas in females, there are two or three frenulums, with few exceptions (Plate 2, figs. 14, 15). Common (1960) and Nazmi (1963) have been followed in the present study for naming the different veins of fore and hind wings.

ABDOMEN (Plate 1, fig. 2)

The abdomen consists of 10 segments. The first segment is reduced and its sternum is either membranous or wanting. Segments 8, 9 and 10 are greatly modified in order to form the genitalia. The abdomen may be densely or sparsely clothed with scales and hairs. The caudal extremity of females of some of the species are provided with tuft of anal hairs.

GENITALIA

Usually 8^{th} to 10^{th} abdominal segments are modified to form the genitalia. The principle parts are generally withdrawn into the 8^{th} segment and consequently they may be clearly visible only when microscopic preparation is made and studied under a high magnification.

MALE (Plate 2, figs. 18, 19)- It has following parts:-

Tegumen: It is dorsal part of the 9^{th} segment which is usually large and sclerotized to form a hood-like structure and serve as a base for the attachment of other genital appendages. It usually forms a complete transverse ring with the sternite which is modified to form vinculum.

Pedunculi: The lateral extensions of tegumen, which articulate with the dorsal end of vinculum, are called pedunculi.

Vinculum: It is actually derived from the 9^{th} sternite and is a thin U or V-shaped structure that remains continuous across the ventral side.

Saccus: Mid-ventrally to the vinculum, there is a blind tubuler process, extending cephalad inside the body, known as saccus.

Uncus: This forms the dorsal process of the 10^{th} segment and is in close contact with the caudal end of the 9^{th} tergite. It is well sclerotized structure which occupies the central upper part of the tegumen. This structure is of great taxonomic value as it exhibits considerable amount of variation with respect to shape and size among different species.

Gnathos: In close proximity and lateral to socci there are a pair of arms, called gnathos. These articulate with caudal margin of tegumen and are derived from the sternum of 10^{th} segment.

Tuba-analis: it is the posterior most part of the digestive tract which is ventral to tegumen and uncus.

Anellus: This is the beginning of the central part of the diaphragm which gets evaginated dorso-ventrally to form a funnel-like cone around penis from where the latter protrudes out of the body.

Aedeagus: It is the outside covering of penis and is a stout tube, with an opening on the side near the base. This receives the seminal duct and contains the reversible balloon like membrane known as vesica which is most delicate structure and often bears sclerotized spines, scobinated patches, spicules or a band, termed as cornuti and penetrates into bursae-copulatix of the female during copulation. It is variable in size and with or without cornuti.

Valva-Valvae: These are paired clasping organs which basally articulate with the vinculum and lie in a latero-ventral position. The front margin is termed as costal margin and the outer one as termen. Its ventro-proximal region, bearing various process is termed as sacculus. The dorsal distal setose part of valva is called cucullus. The sclerotized dorsal proximal margin of the valva is known as costa. The shape of the valva and its manner of articulation appears to be highly variable among various genera. Mostly it is reduced to sub-rounded or pointed apex, simple and weakly sclerotized lobe but becomes large in some genera. It often gets divided into two lobes, a feature that runs through many genera and provides a good taxonomic characters for their diagnosis. The costal lobe may be simple or rigidly sclerotized and gets developed as a long curved spines.

FEMALE: (Plate 2, fig. 20) It has following parts:-

Papillae anales: They are typically the external structure of 9^{th} and 10^{th} segments, forming a pair of lobes between which the anus and ostium oviducts open outside. They are usually more or less separate, soft, rounded, blade like and strongly setose structures.

Apophyses: These are derived from the cephalo-dorsal or lateral edges of the 8^{th} and 9^{th} tergites. Those of the 8^{th} segment are anterior apophyses and those of 9^{th} segment are posterior apophyses. Both the apophyses i.e. anterior and posteerior are paired structure and are of same size or varying size.

Ductus bursae: This is a tubular structure in between ostium bursae and corpus bursae. It is membranous or slightly sclerotized and short or long.

Corpus bursae: The ductus bursae end in the form of a blind sac which is known as corpus bursae. The variable shape of corpus bursae are of important taxonomic value. Sometimes sclerotized structure of different shape and size are found at different places of corpus bursae which are known as signum. The presence or absence, number and location in corpus bursae, size and shape of signum are of great taxonomic value.

CHAPTER-5

TAXONOMIC STUDIES

TAXONOMIC STUDIES

The moths belonging to family Pyralidae are mostly small to moderate size. Majority of them is dull coloured but few are brightly coloured too. The following characters recognize these:

Head with the frons smooth, moderately rounded to an acute protuberance, with or without a corneous point. Proboscis developed, reduced, rudimentary or absent. Labial palpi short or long, porrect in the form of a snout, upturned, slightly down-curved, naked or covered with scales. Maxillary palpi developed, dilated, with scales or reduced. Compound eyes developed or reduced. Ocelli developed, reduced or absent. Antennae variable such as simple, filiform, serrate, laminate, pectinate, ciliate or fasciculate. Wings very much vary in venation. Fore wing with 1^{st} A either present in terminal part or absent; vein 3^{rd}A present or absent, if present then short, free or ending near anal margin or meets 2^{nd} A in the middle. Hind wing with $Sc+R_1$ anastomosing with Rs beyond the cell for a short distance or near to margin. Discocellür cell may be closed or open. Abdomen with praecinctorium developed or absent.

Various workers have divided this family into number of subfamilies. However, the following key has been provided to separate only 5 subfamilies under which the genera and species were dealt in the present work.

Key to the subfamilies of Pyralidae

1. Hind wing with median vein pectinated on upper side----------------------------2
   Hind wing with median vein not pectinated on upper side-----------------------3
2. Fore wing with vein R_5 ---**Crambinae**
   - Fore wing without vein R_5 --**Anerastiinae**
3. Fore wing with vein 1^{st} A present only in terminal part; proboscis. highly reduced or absent---**Schoenobiinae**

- Fore wing with vein 1^{st} A absent; proboscis present--------------------------------4

4. Fore wing with vein R_2 generally stalked with R_{3+4}------------------- **Nymphulinae**

- Fore wing with vein R_2 always free------------------------------------**Pyraustinae**

Subfamily Anerastiinae

Diagnostic characters: Head with labial palpi moderate to well developed. Maxillary palpi of moderate size or small. Proboscis well developed. Ocelli usually well developed. Fore wing with R_5 always absent. Hind wing with median veins always pectinated on upper side; vein M_3 absent; frenulum single in both the sexes.

Under this subfamily only 2 genera could be examined which may be recognized by the following key:-

Key to the genera of Anerastiinae

1. Fore wing with vein M_3 absent------------------------*Maliarpha* Ragonot

- Fore wing with vein M_3 present--------------------------*Saluria* Ragonot

Maliarpha Ragonot

Ragonot 1888, *Nouveux generes et especies de Phycitidae et Galleridae,* Paris, p.48

(Type species: *Maliarpha separatella* Ragonot)

Diagnostic characters: Labial palpi long, obliquely upturned, about 3x as long as head, thickly scaled; 2^{nd} joint not hollow. Maxillary palpi filiform. Antennae laminate, ciliated with a sinus at base of shaft containing a ridge of scales. Fore wing long and narrow; vein M_3 absent; M_2 from above lower angle of cell; M_1 from below upper angle of cell; R_5 absent; R_3 and R_4 stalked; R_2 and R_1 from cell and free. Hind wing with Cu_2 from just before lower angle of cell; M_3 absent; Cu_1 and M_2 stalked; M_1 and Rs stalked at the point of origin; Rs anastomosing with $Sc+R_1$.

This genus is known by a single species i.e. *Maliarpha separatella* Ragonot from India, which is reported as a pest of rice and included in the present study.

Maliarpha separatella Ragonot

Ragonot 1888, *Nouveux generes et especies de Phycitidae et Galleridae,* Paris, p.48

Anerastia pallidicosta Hampson 1896, *Faun. Brit. Ind. Moths,* **4** (1): 57 (Synonymised by Martin 1959)

Enosima vectiferella Ragonot 1901, In: Romanoff, *Memoires sur les Lepidopteres*, **8**: 391 (Synonymised by Martin 1959)

Diagnostic characters: Head and thorax in male rufous; in female much reddish. Fore wing in male brownish–ochereous with dark brown, parallel to costal margin; in female whitish-yellow to yellowish orange with a single fuscous discal spot; tornus rounded. Hind wing yellowish-white (Plate 6, figs. 71, 72, 73; Plate 19, figs. 226; Plate 20, figs. 251, 252).

Neuration

Fore wing: Sc reaching costal margin at about two-thirds length of wing; R_1 from cell at about three-fourths distance of its length reaching costal margin at more than two-thirds length of wing; R_2 from upper angle of cell and reaching costal margin at more than four-fifths length of wings; R_3 and R_4 stalked; R_3 separated from R_4 at half of distance of its length; R_5 absent ; M_1 well separated from R_{3+4} and quite apart from M_2; Cu_1 and M_2 from lower angle of cell and well separated, diverging distally; M_3 absent; Cu_2 from cell at before some distance of its lower angle; 2^{nd} A reaching margin (Plate 3, fig. 21).

Hind wing: Sc $+R_1$ reaching costal margin at about four-fifths length of wing; R_5 just after its origin, anastomose with $Sc+R_1$ slightly up to more than two-thirds length of wing, then separated and reaching to apex ; M_1 from upper angle of cell, approximated to Rs near its origin; M_2 and Cu_1 stalked and from lower angle of cell; M_3 absent; Cu_2 from cell just before lower angle of cell; 1st A, 2nd A and 3rd A complete (Plate 3; fig. 22)

Genitalia

Male: Uncus triangular. Gnathos triangular and broader than uncus; tip slightly blunt and larger than uncus. Valva elongated; costal margin gradually concaves; saccular margin gradually convex; apical margin blunts. Vinculum with U-shaped saccus. Aedeagus short, wide and renal-shaped; cornutus present (Plate 11, figs.146, 147).

Female: Papillae anales elongated and setose. Anterior apophyses slightly shorter than posterior apophyses. Ductus bursae short with wall slightly sclerotized. Corpus bursae balloon shaped; signum present (Plate 15, fig. 201).

According to Martin (1959) signum is very much variable. In some cases signum consisting of two plates, in some there is only one plate, whereas in other signum is absent.

Length: 9-12 mm

Wing span: 18-24 mm

Material examined: MAHARASHTRA: 4 exs., -. X. 1909, Bassein Fort, Bombay, A.M. Coll. **[NPC]**

Distribution: Burkhino Faso, Cameroon, China, Ghana, India (Assam, Nagaland, Punjab), Ivory Coast, Kenya, Madagascar, Malawi, Myanmar, Malagasy Republic, Nigeria, Papua New Guinea, Senegal, Sri Lanka, Sierra Leone, Swaziland, Tanzania, Uganda, Zambia,

Saluria Ragonot

Ragonot 1887, *Ann. Soc. ent. Fr.*, p. 258

Poujadia Ragonot 1888, *Nouveux generes et especies de Phycitidae et Galleridae*, Paris, p. 42 (Synonymised by Hampson 1918[b])

Baroda Ragonot 1888, *Nouveux generes et especies de Phycitidae et Galleridae,* Paris p. 42 (Synonymised by Hampson 1918[b]) p. 42

Goya Ragonot 1888, *Nouveux generes et especies de Phycitidae et Galleridae,* Paris p. 43 (Synonymised by Hampson 1918[b])

Pectinigeria Ragonot 1888, *Nouveux generes et especies de Phycitidae et Galleridae,* Paris p. 43 (Synonymised by Hampson 1918[b])

Cayuga Hulst 1888, *Ent. Am.,* **4** : 116 (Synonymised by Hampson 1918[b])

Atascosa Hulst 1890, *Trans. Am. ent. Soc.,* **17**: 210 (Synonymised by Hampson 1918[b])

Paramatta Hampson 1901, Rom. Mem., **8**: 336 (Synonymised by Hampson 1918[b])

Ollia Dyar 1904. *J. N. Y. Ent. Soc.,* **12**: 107 (Synonymised by Hampson 1918[b])

Eumoorea Dyar 1917, *Insec. Inscit. Menstr.,* **5**: 91 (Synonymised by Hampson 1918[b])

(Type species : *Saluria maculivittella* Ragonot)

Diagnostic characters: Labial palpi obliquely upturned, about 1.5x as long as head. Maxillary palpi filiform. Frons smooth with slight tuft of hairs. Antennae of male typically with long uniseriate branches. Hind tibiae fringed with hairs. Fore wing long and narrow; apex rounded; termen evenly curved; vein Cu_1 from close to lower angle of cell; M_2 and M_3 stalked; M_1 from below upper angle of cell; R_5 absent; R_3 and R_4 stalked; R_1 and R_2 from cell and separate. Hind wing with vein Cu_2 from before lower angle of cell; Cu_1 and M_3 stalked; M_2 absent; M^1 and R_5 shortly stalked; $Sc+R_1$ free.

This genus is known by 12 species from India. The present study include *S. inficita* which is reported as a pest of rice.

Saluria inficita (Walker)

Walker 1863[a], *List Spec. Lep. Ins. Coll. Brit. Mus.,* **27** : 30

Acrobasis inficita Walker 1863 [a] *List. Spec. Lep. Ins. Coll. Brit. Mus.,* **27** : 30

Poujadia inficita (Walker); Hampson 1896, *Faun. Brit. Ind Moths.,* **4** (1): 58

Saluria inficita (Walker); Hampson 1918[c], *Proc. zool.Soc. Lond.*, p. 96

Diagnostic characters: Body pale, dull, straw-coloured. Labial palpi with 3[rd] joint conical in male, longer, lanceolate in female. Fore wing long, narrow, apex rounded, termen evenly curved; costal fasica narrow, mostly clouded with brownish-cinereous; discocellular spot single and dark; submarginal line dark, denticulated. Hind wing pale, slightly hyaline (Plate 6, figs. 74, 75, 76; Plate 19, figs. 227; Plate 20, figs. 253, 254).

Neuration

Fore wing: Sc reaching costal margin at two-thirds length of wing; R_1 from cell at more than three-fourths distance of its length, reaching costal margin at fifth-sevenths lengths of wing; R_2 from upper angle of cell, running very close to R_{3+4} up to one-sixths distance of its length then diverging and reaching costal margin at five-sixths length of wing; R_{3+4} stalked and separated from each other at two-thirds distance of its length; R_4 to apex ; R_5 absent; M_1 quite apart from below upper angle of cell; M_2 and M_3 stalked, separated from each other at more than half distance of its length, diverging afterwards; Cu_1 from close to lower angle of cell; Cu_2 from cell at short distance before lower angle of cell; 2[nd] A reaching margin (Plate 3, fig. 23).

Hind wing: $Sc+R_1$ separate, reaching costal margin before apex; Rs and M_1 stalked beyond cell, diverging distally; M_2 and Cu_1 stalked and separated from each other at about half distance of its length; M_3 absent; Cu_2 from before lower angle of cell; 1[st] A, 2[nd] A and 3[rd] A complete (Plate 3, fig. 24).

Genitalia

Male: Uncus large, broad at base, trilobed at apex; middle lobe with rounded apex; side lobes triangular with sclerotized hooks: Gnathos short, broad, rounded. Valva elongated, falcate shaped, densely setose; apical margin narrow, with thick and long hairs. Vinculum large, broad and sclerotized. Saccus U-shaped. Aedeagus cylindrical; cornutus absent (Plate 11, figs. 148, 149).

Female: Papillae anales broad, densely setose. Posterior apophyses shorter than anterior apophyses. Ductus bursae very short, membranous and narrow. Corpus bursae large, subrounded, balloon shaped; signum prominent, situated in middle of corpus bursae (Plate 15, figs. 202).

Length : 9-18 mm

Wing span: 16-20 mm

Material examined: BIHAR: 1 ex., 30. IX. 1908, on grass; 2 ex., 5. X. 1908, at light, (labelled as "Pusa Bengal"); 1 ex., 2. IV. 1910; 3 exs., 15, 16, 20. VII. 1910; 2 exs., 14, 27. VII. 1910; 2 exs., 24, 26. VIII. 1910, (all T.B.F. Coll); 1 ex., 17. IX. 1923, Peries Coll.; 1 ex., 3 VII. 1924. 1924, Mackenzie Coll.; 4 exs., 2, 7. IX. 1926, 3 exs., 6,7,9. IX. 1926, Pillai Coll.; 1 ex., 30. VI. 1927, E. Hassan Coll. **[NPC]**

Distribution: India (Bihar, Karnatka, Madhya Pradesh, Orissa, Tamil Nadu, Uttar Pradesh), Sri Lanka

Subfamily Crambinae

Diagnostic characters: Head with frons smooth, subrounded or produced forward, with or without corneous point. Labial palpi well developed. Ocelli may or may not be present. Proboscis reduced. Fore wing either with R1 free or closely approximated or anastomosed with Sc; R_5 free or stalked with R_{3+4}; 3rd A reduced and feeble. Hind wing with pectination on upper side.

Four genera could be examined under this subfamily which can be distinguished with the help of following key-:

Key to the genera of Crambinae

1. Head with ocelli--2

- Head without ocelli; frons not produced, broadly subrounded. Fore wing with R_1 coincident with Sc. Hind wing with the cell closed ------------*Borer* Guenee

2. Fore wing with R_5 stalked with R_{3+4} ------------------------*Ancylolomia* Huebner

- Fore wing with R_5 free from R_{3+4}-- 3

3. Frons with a corneous point. Fore wing with R_1 nearly always free ------------- -- *Chilo* Zincken

- Frons without a corneous point. Fore wing with R_1 nearly always confluent with, or closely approximated to Sc ----------------------------*Chilotraea* Kapur

Ancylolomia Huebner

Huebner 1825, *Verz. bekant. Schmett.*, p 363

Jartheza Walker 1863[a], *List Spec. Lep. Ins. Coll. Brit. Mus.*, **27**: 183. (Synonimised by Moore 1884-87)

Pseudoctenella Strand 1907, *Bull. Soc. ent. Fr.*, p .175 (Synonymised by Shibuya 1928-29)

Ctenus Mabille 1906, *Ann, Soc. ent. Fr.* , p 32 (preoccupied because this genus is previously used for Arachnida)

Tollia Amsel 1949. *Bull. Soc. Fouad ler D'Ent.,* Cairo, **33**: 275. (Synonymised by Shaffer *et al.,* 1996)

(Type species; *Ancylolomia palpella* (Dennis & Schiffermueller))

Diagnostic characters: Labial palpi porrect, covered with thick hairs. Maxillary palpi triangularly scaled and half of the length of labial palpi. Antennae long and broadly pectinated in male whereas serrated in female. Legs smooth and long; hind tibiae with four short, equal spurs. Fore wing with veins Cu_1 , M_3, M_2 from lower angle of cell; M_1 from upper angle of cell; R_5, R_4, R_3 stalked; R_2 free; R_1 coincident with Sc. Hind wing with vein Cu_1 originating closely to lower angle of cell; M_3, M_2 slightly stalked ; M_1 from above middle of cell and feeble; Rs anastomosing to $Sc+R_1$.

This genus has 5 species from India, of which *Ancylolomia chrysographella* (Kollar) is a minor pest as a stem borer.

Ancylolomia chrysographella (Kollar)

Kollar 1848, In: Hugael, *Kaschmir und das Reich. Siek.*, **4**: 494.

Chilo chrysographella Kollar 1848, In: Hugel, *Kaschmir. und das Reich. Siek.*, **4**: 494

Jartheza chrysographella (Kollar); Walker 1863[a], *List Spec. Lep. Ins. Coll. Brit. Mus.*, **27**: 184

Ancylolomia chrysographella (Kollar); Warren 1888, *Proc. zool. Soc. Lond.*, p. 337.

Ancylolomia capensis Zeller 1863, *Monogr. Chilo et Cramb.*, p.11 (Synonymised by Hampson 1895)

Ancylolomia indica Felder & Rogenhoeffer 1874, *Reise Novara Lep.*, **2** (2), pl. 137 (Synonymised by Hampson 1895)

Ancylolomia sansibarica Zeller 1877, *Hor. Soc. Ent.Ross.*, **13**: 23 (Synonymised by Hampson 1895)

Ancylolomia japonica Zeller 1877, *Hor. Soc. Ent. Ross.*, **13** : 24 (Synonymised by Shibuya 1928-29)

Ancylolomia taprobanensis Zeller 1877, *Hor. Soc. Ent. Ross.*, **13**: 25 (Synonymised by Hampson 1895)

Ancylolomia argentata Moore 1884-87, *Lep. Ceylon*, **3**: 382. (synonymised by Hampson 1895).

Diagnostic characters: Body colour brownish ochreous. Fore wing long, acute, narrow, costa straight; apex produced; outer margin concave below the apex and convex backwards; silvery and yellow fascia in the interspaces between veins in distal area beyond the cell; fascia in interspaces 1 and 7 shorter than the rest; each fascia defined beneath by a yellow fascia with streak of black scales on it; submarginal line silvery and minutely dentate; marginal band whitish with a series of dark specks; cilia silvery. Hind wing long and broad; apex produced; outer margin very oblique; convex in middle; whitish; cilia white (Plate 6, figs. 77, 78, 79; Plate 19, fig. 228; Plate 20, figs. 255, 256).

Neuration

Fore wing: Sc reaching costal margin at more than three-fourths the length of the wing; R_1 from cell at two-thirds of its length and coincident with Sc at half of the length of wing; R_2 from before the end of cell at half of the length of wing where R_1 coincident with Sc; R_3, R_4 and R_5 stalked and arising from upper angle of cell; R_3 from R_4 at two third of its length; R_4 from R_5 at just before half distance from end of cell to apex of wing; M_1 close to R_{3+4+5} than M_2 basally, diverging distally; M_2 parallel to M_1 from end of cell to outer margin of wing; M_3 more close to Cu_1 basally than M_2 and diverging distally; Cu_2 from cell at two-thirds length of cell; 2nd A reaching margin; 3rd A feeble for a short distance (Plate 3, figs.25).

Hind wing: $Sc+R_1$ reaching costal margin at near to apex of wing; Rs just after its origin, anastomose with $Sc+R_1$ up to more than half of the length of wing, then separated and reaching apex; M_1 from upper angle of cell, separate and parallel to Rs; M_2+M_3 with a short stalk and close to Cu_1 basally, diverging distally; Cu_2 from cell at about half of its length; 1st A, 2nd A and 3rd A complete (Plate 3, figs. 26).

Genitalia

Male: Uncus slender and pointed at the tip, bearing two curved subapical dorsal spines. Ganthos pointed, bent at the tip, sclerotized, longer than uncus. Valva more or less rectangular; costal margin bearing two spines; apex broad with tuft of hairs. Vinculum short and globular. Saccus U-shaped and small. Aedeagus rod-shaped, swollen in middle, produced apically; proximal end slightly bent, terminates in a round knob; cornuti absent (Plate 11, figs. 150, 151, 152).

Female: Papillae anales broad, densely setose. Anterior apophyses and posterior apophyses thick, chitinized, more or less of equal size. Ductus bursae very small, membranous. Corpus bursae very large, elongated with the wall slightly rough and wrinkled; signum absent (Plate 15, figs. 203).

Length: 8-15 mm

Wing span: 16-40 mm

Material examined: ANDAMAN ISLAND: 3 exs., 6, 7. IV. 1927, Mt. Harriet, 1200 ft., Ferrar Coll.; MEGHALAYA: 1 ex., 12. X. 1924, 1 ex., 6. XI. 1924, 1 ex., VI. 1920, 1 ex., V. 1924, 1 ex., IX. 1917, 1 ex., 20. V. 1924, (all from Shillong), all Fletcher Coll.; 3 exs., 3. VI. 1918, 1 ex., 1. VI. 1918, Shillong, *at light,* Y. R. Rao Coll.; ASSAM: 1 ex., 26. X. 1911, Sibsagar, C. C. G. Coll.; 1 ex., -. IV. 1908, Nanjgow, A.M. Coll.; 1 ex., -. IV. 1908, Guwahati, A. M. Coll.; BIHAR: 1 ex., IX. 1907, Chakradharpur, A.M. Coll.; 1 ex., 16-25. III. 1928, Hararibagh, P. V. Isaac Coll.: 1 ex., 20. VII. 1910, 1 ex., 21. 10. 1910, 1 ex., 1. IV. 1911, 1 ex., 22. III. 1915, 1 ex., 22. X. 1927, T.B.F. Coll.; 1 ex., 29. III. 1914, 1 ex., 28. V. 1914, 1 ex., 20. III. 1915, 1 ex., 20. IV. 1915, 2 exs., 8. 10. VIII. 1915, 1 ex., 24. IX. 1915, 2 exs., 2. X. 1915, 2 exs., -. III. 1916, all Boy Coll.; 2 exs., 27, 28. IV. 1916, U. Bahadur Coll.; 3 exs., 5. VI. 1916, H. Singh Coll.; 5 exs., 4. VIII. 1916, 1 ex., 5. VIII. 1916, 1 ex., 19. XI. 1916, 2 exs., 23. XII. 1916, all *on rice stem,* no Coll.; 6 exs., 25, 26, 27, 31. VIII. 1916, all *on Dabli grass,* D. Nandan Coll.; 1 ex., -. V. 1917. H. M. L. Coll.; 2 exs., 13. VIII. 1921, 2 ex., 22. IV. 1924, Rangi Coll.; 1 ex., 29. X. 1923, Peries Coll.; 1 ex., 7. VIII. 1924, Krishna Coll.; 1 ex. 4. X. 1928, *boring Andropogon Stem,* no Coll.; 1 ex., 22. IX. 1931, D. P. Singh Coll.; 1 ex., 4. VIII. 1932, Bose Coll.; 1 ex., 19. IV. 1935, 2 exs., 18, 23. VIII. 1935, *at light,* H. S. Purthi Coll.; (all from Pusa); 2 exs., -. IX. 1907, A. M. Coll.; 3 exs., 26, 30. III. 1928, P.V. Issac Coll.; (all from Ranchi) MADHYAPRADESH: 1 ex.,- III. 1907, Fletcher Coll.; 1 ex., -. II. 1908, C. S. M. Coll.: (all from Nagpur); 2 exs., –. III. 1907, Balughat, A.M. Coll.; ORISSA: 3 exs., -. X. 1906, Balasore, A. M. Coll.; 1 ex., -. X. 1906, 1 ex. -. II. 1907, A.M. Coll.; 1 ex., 23. V. 1941, Panda Coll.; (all from Cuttack).; WEST BENGAL: 1 ex., 7. XI. 1924, Calcutta, C. Mukherjee Coll. **[NPC]**

Distributions: Bangladesh, China, Taiwan, Throughout India, Japan, Myanmar, Pakistan, Sri Lanka

Borer Guenee

Guenee 1862, In: Maillard, *Notes sur l'ile de la Reunion* (Bourbon), (2) Annexe (G): p.68

(Type species: *Phalaena saccharalis* Fabricius)

Diagnostic characters: Head with frons smooth and subrounded. Labial palpi porrect, slightly curved downwards distally, long about 3 times to the length of head. Antennae in male serrate and ciliated, in female setaceous. Maxillary palpi triangularly dilated with scales. Hind legs with outer tibial spurs about half of inner spurs. Fore wing with R_1 coincident with Sc; apex narrow and produced. Hind wing with the cell closed.

This genus may be distinguished from genera *Ancylolomia* Huebner, *Chilo* Zincken and *Chilotraea* Kapur by the absence of ocelli. This genus is known by a single subspecies i.e. *Borer sacchariphagus indicus* (Kapur) from India infesting rice crop which is included in the present study.

Borer sacchariphagus indicus (Kapur)

Kapur 1950, *Trans. ent. Soc. Lond.*, **101** (Pt. 11) : 414

Chilo indicus (Kapur); Bleszynski 1966, *Acta zool. cracov.*, **11**: 493

Chilo sacchariphagus indicus (Kapur); Bleszynski 1970, *Bull. Brit Mus.* (*Nat. Hist.*) (Entomology), London, **25** (4): 187

Borer sacchariphagus indicus (Kapur): Arora 2000, *Rec. zool. Surv. India,* Occasional paper No. **181** : 47

Diagnostic Character: Frons smooth, subrounded to flat; corneous point and ventral ridge absent. Fore wing with ground colour light brown; apex acute; discal spot single; streaks on and between the veins; a series of small dark spots along the termen; cilia darken along basal half. Hind wing slightly lighter than fore wing; suffused, light to dark brown towards apex (Plate 6, figs. 80, 81, 82; Plate 19, fig. 229; Plate 20, figs. 257, 258)

Neuration:

***Fore wing*:** Sc reaching costal margin at more than two-thirds length of wing; R_1 from cell at near about half of the length of cell anstomosing with Sc to a long distance and then separate; R_2 separate, from beyond the upper angle of cell; R_3 and R_4 stalked; R_3 from R_4 at about two-thirds of its length and very close to R_2 basally; R_5 and M_1 close basally from upper angle of cell, diverging distally; M_2 and M_3 from lower angle of cell, close basally and diverging distally; Cu_1 distant from M_3; Cu_2 from cell at before half of the length of cell; 2^{nd} A complete and reaching to margin; 3^{rd} A short and incomplete (Plate 3, fig. 27).

***Hind wing*:** Sc $+R_1$ reaching costal margin at near to apex of wing, Rs just after its origin from near upper angle of cell, anastomose with $Sc+R_1$ upto two-thirds length of wing, then separated and reaches to apex of wing; M_1 from upper angle of cell; M_2 and M_3 from lower angle of cell and very close basally, diverging distally; Cu_1 distant from M_3; Cu_2 from cell at about half of its length; 1st A complete; 2^{nd} A and $3I^{rd}$ A also complete but feeble (Plate 3, fig. 28).

Genitalia

***Male*:** Uncus triangular, beak-like. Gnathos sclerotized and as long as uncus. Valva without pars basalis; costal margin slightly sclerotized and more or less bent; apical margin blunt. Vinculum with large V-shaped saccus. Aedeagus broad and terminated in oval, elongate, sclerotized projection; cornuti arranged in two unequal distinct patches (Plate 11, figs. 153, 154, 155).

***Female*:** Papillae anales funnel-shaped and setose.Anterior apophyses longer than posterior apophyses. Ductus bursae heavily sclerotized, slightly convoluted, with longitudinal ridges. Corpus bursae oblong, sclerotized with few oblique folds; signum absent (Plate 15, fig. 204).

Length: 12-17mm

Wing span: 20-36mm

Material examined: BIHAR: 12 exs., 17-18, 21, 24, 30. VIII. 1917, *on Iwar Stem,* all R.S. Coll.; 1 ex., 27.VIII. 1917, *on sugarcane,* no Coll.; 1 ex., 14. VII. 1917, 1 ex., 19. III. 1918, *all on sugarcane* no Coll.; 2 ex., 26, 25. III. 1918, *on Iwar stem,* no Coll.; 2 exs.,22. III. 1918. *on rarhi stem,* Boy Coll.; 2 ex. 26, 28.IX. 1917, *on Jowar stem,* no Coll.; 1 ex., 23. IX. 1917, *on sugarcane,* no Coll.; 3 exs., 16. III. 1918, *on Rarhi stem,* Boy Coll.;2 exs., 23. III. 1915, *on Iowar stem,* no Coll.; (all from Pusa) **[NPC].**

Distribution: Throughout India, Pakistan, Sri Lanka

Chilo Zincken

Zincken 1817, *Mag. Ent.* Germ., **2**: 34

Diphryx Grote 1881, *Bull. U.S. Geol.Surv.*, **6(2)**: 273 (Synonymised by Hampson 1895)

Nephalia Turner 1911, *Ann.Qd. Mus.*, **10**: 113 (Synonymised by Hampson 1895)

Hypiesta Hampson 1919[b], *Ann. Mag. nat. Hist.*, (s.9) **3**: 538 (Synonymised by Bleszynski 1966)

Silveria Dyar 1925, *Insecutor Insict menstr.*, **13** : 10 (Synonymised by Bleszynski 1962)

Diatraenopsis Dyar and Heinrich 1927, *Proc. U.S. natn. Mus.*, **71**: 39. (Synonymised by Bleszynski 1970)

(Type species: *Tinea phragmitella* Huebner)

Diagnostic characters: Proboscis poorly developed. Labial palpi porrect, slightly down curved, covered with long scales and hairs. Maxillary palpi dilated with scales. Frons produced forward with a conical projection. Antennae minutely serrate and ciliated in malewhere as setaceous in female. Hind legs with outer tibial spurs about two-third length of inner spurs. Fore wing with vein Cu_1 arising before lower angle of cell; M_3 and M_2 separate at origin; M_1 from below upper angle of cell; R_5 from upper angle of cell; R_3 and R_4 stalked; R_2 free and originate from near the base of stalk of R_3 and R_4; R_1 curved forward and close to Sc but do not anastomose with it. Hind wing with vein Cu_1 from near lower angle of cell; M_2 and M_3 arising from same point of lower angle of cell and separate but sometimes slightly stalked; M_1 from upper angle of cell; $Sc+R_1$ and R_s anastomosing beyond cell.

This genus has 5 species from India, of which two species namely *C. suppressalis* (Walker) and *C. partellus* (Swinhoe), are associated with rice. These can be distinguished by the following key:-

Key to the species of *Chilo*

1. Ventral surface of the frons flattened and produced as a ridge. Fore wing with dark specks irregularly dispersed all over the area, sometimes forming patches; terminal dots black and distinct---------------------------*C. suppressalis* (Walker)

\- Ventral surface of frons smooth and without any ridge. Fore wing whitish brown with three rather diffused spots on discocellulars and a light patch from apex towards middle of hind margin, but stopping half way; a series of terminal spots small, entire and black ----------------------*C. partellus* (Swinhoe)

Chilo partellus (Swinhoe)

Swinhoe 1885, *Proc. zool. Soc.* Lond., p. 879

Crambus partellus Swinhoe 1885, *Proc. zool. Soc.* Lond. , p. 879

Chilo partellus (Swinhoe); Bleszynski and Collins 1962, *Acta. zool. cracov.*, 7 : 243

Crambus zonellus Swinhoe 1884, *Proc. zool. Soc.* Lond., p. 528. (Preoccupied under genus *Crambus* Fabricius vide *Crambus zonellus* Zeller 1847 which is synonymised with *Euchromius tamburiellus* (Duponchel) and is not available for use).

Argyria lutulentalis Tams 1932, *Entomologist.* **65** : 127. (Synonymised by Martin 1954)

Diagnostic characters: Body yellowish brown and suffused with fuscous. Labial palpi covered with dark brown to whitish scales; 2nd joint more than 4x the length of 3rd joint. Frons conical with a distinct corneous point: ventral surface smooth and without a ridge. Fore wing varying from yellow to brown dusted with fuscous scales; costal area darker; traces of dark scales below middle and at lower angle of cell; veins of outer area slightly streaked with fuscous; three diffused spots on discocelluler and a light band running from apex towards the centre of inner margin but stopping half way; subterminal line brown and ill defined; a marginal series of black specks, cilia slightly darker near base. Hind wing dirty white to grey (Plate 6, figs. 83, 84, 85; Plate 19, fig. 230; Plate 20, figs. 259, 260).

Neuration

Fore wing: Sc reaching costal margin at two-thirds length of wing: R_1 from cell at less than two-thirds of its length and reaching costal margin at more than two-thirds length of wing; R_2 separate and close to R_{3+4}, arising from before upper angle of cell; R_3 and R_4 from upper angle of cell and stalked; R_5 basally close to M_1 than R_{3+4} and diverging distally; M_2, M_3 from lower angle of cell, close basally, diverging distally; Cu_1 distant basally from M_3; Cu_2 from cell at two-thirds of its length; 2nd A complete and reaching to margin, 3rd A incomplete (Plate 3, fig. 29).

Hind wing: $Sc+R_1$ reaching costal margin at near to apex of wing; Rs anastomosing with $Sc+R_1$ just after its origin up to two-thirds length of wing, then separated from it and reaches to apex of wing. M_1 from upper angle of cell, diverging distally; M_2 and M_3 originating from a single point of lower angle of cell and diverging distally; Cu_1 shortly distant from M_3; Cu_2 from two-thirds length of cell; 1st A complete; 2nd A and 3rd A weak (Plate 3, fig. 30).

Genitalia

Male: Uncus triangular, beak-shaped, flat, highly sclerotized and sharply pointed with setae. Gnathos shorter than uncus. Valva with costal margin more or less straight; apical margin slightly pointed. Vinculum with saccus V-shaped. Aedeagus long, cylindrical and divided for its most of its length; cornutus absent (Plate 11, figs. 56, 57, 58).

Female: Papillae anales funnel shaped and hairy. Anterior apophyses about 2x the length of posterior apophyses. Ductus bursae narrow, weakly sclerotized and about 3-4x longer than corpus bursae. Corpus bursae round, slightly longer than broad; signum represented by a sclerotized lamellate patch in the centre of corpus bursae (Plate 15, fig. 205).

Length: 11-18 mm

Wing span: 18-36 mm

Material Examined: BIHAR: 3 exs., 25. V. 1905, 1 ex., 27. X. 1905, *on maize stalk*, C. S. M. Coll.; 3 exs., 18, 19, 22. V. 1905, *on maize*, K. D. S. Coll.; 1 ex., 10. V. 1906, no Coll.; 2 exs., 20. V. 1907, B. S. Coll.; 3 exs., 26, 27, 30. VIII. 1907, *on maize*, 1 ex., 6. IX. 1907, *on maize*, 1 ex., 23. VI. 1908, hibernating in Jowar, all M. Singh Coll.; 1 ex., 10. VIII. 1908, *Sorghum Stem*, S. Kar Coll.; 1 ex., 27. VIII. 1909, *Chichera fruit*, no Coll.; 2 ex., 4. V. 1912, 1 ex., 26. V. 1912, 2 exs., 1, 9. VI. 1912, 1 ex., 21. 6. 1915, 1 ex., 13. VII. 1918, 2 ex., 22, 23. VII. 1918, 2 exs., 26, 28. VII. 1918, 2 exs., 3, 16. X. 1918, 1 ex., 26. IV. 1919, 1 ex., 16. VI. 1919, *all on rice*, no Coll.; 2 ex., 19. VII. 1912, 2 ex., 12. VIII. 1912, R. M. P. Coll.; 3 ex., 12. 6. 1915, 1 ex., 14. VI. 1915, *all on sugarcane*, no Coll.; 2 exs., 4. IX. 1927, 1 ex., 11. IX. 1927, 1 ex., 29. X. 1927, *all on maize*, Haq Coll.; 3 exs., 30. III. 1927, 1 ex., 31. III. 1927, *all on sorghum*, Haq Coll.; 1 ex., 18. III. 1928, 2 exs., 16, 17. VII. 1928, *all on maize*, H. H. Singh Coll.; 1 ex., 7. X. 1917, 1 ex., 11. IX. 1917, 1 ex., 29. XI. 1917, 1 ex., 21. XII. 1917, *all boring Sudan grass*, no Coll.; 1 ex., 22. III. 1926, *on Jowar*, Chatterjee Coll.; (all from Pusa). 1 ex., -. 1904 Saran *on maize*, Mackenzie Coll.; DELHI: 1 ex., 16. VII. 1938, H. L. Bhatia Coll.; 1 ex., 1. VIII. 1940, *on maize*, 1 ex., 31. VIII. 1940, *on Jowar*, all R. Saran Coll.; GUJARAT: 1 ex., 25. VI. 1904, *on maize*, 1 ex., 13. VII. 1904, 1 ex., 18. VII. 1904, 1 ex. 21. VII. 1904, all Surat, *on Iowar*, F. U. X. Coll.; KARNATAKA: 1 ex., 19. III. 1907, Bellary, *on maize*, Y. R. Coll.; 1 ex., 27. VIII. 1917, Jhalrapatam, *on maize and Iowar*, S. M. H. Coll.; MADHYA PRADESH: 1 ex., 18. VII. 1904, Jabalpur, *on Iowar*, H. M. L. Coll.; 1 ex., 1. XI. 1940, *on maize*, 1 ex.,

4. IX. 1941, *on Iowar,* all from Gwalior, all H. L. Rattan Coll.; ORISSA: 2 exs., 24, 26. VII. 1907, Cuttack, *on rice,* D. N. P. Coll.; TAMIL NADU: 1 ex., 20. III. 1907, Coimbatore, *on Cholam,* no. Coll.; UTTAR PRADESH: 2 exs., 25. VIII. 1914, 1 ex., 26. VIII. 1914, 2 ex., 1. IX. 1914, 2 ex., 2, 3. IX. 1914, all from Cawnpore , *on sugarcane,* E. S. Daniel Coll.; 2 exs., 17. VII. 1914, 1 ex., 18. VIII. 1914, all from Cawnpore , *on Jowar,* E.S. Daniel Coll.; 2 exs., 1. VIII. 1918, 2 exs., 2, 6. VIII. 1918, *all on Andropogon sorghum,* C. S. Misra Coll.; [all from Hapur] **[NPC]**

Distribution: Afghanistan, Comoro Is., Throughout India, Indonesia, Iraq, Japan, Kenya, Malawi, Nepal, Nysaland, Pakistan, Sri Lanka, Sudan, Taiwan, Thailand, Uganda.

Chilo suppressalis (Walker)

Walker 1863[a], *List Spec. Lep. Ins. Coll.Brit. Mus.*, **27** : 166

Crambus suppressalis Walker 1863[a], *List Spec. Lep. Ins. Coll. Brit. Mus.*, **27** : 166

Chilo suppressalis (Walker), Hampson, 1895, *Proc. zool. Soc.* Lond., p. 957.

Chilo simplex Butler 1877[a], *Proc. zool.Soc.* Lond.., p. 400. (Synonymised by Kapur 1950)

Chilo oryzae Fletcher 1928, *Sci. Rep. Agr. Res. Instt.* Pusa, 1926-27: 59. (Synonymised by Kawada 1930)

Chilo orizae Rebel 1940, *Int. ent. Z.*, **25**: 116 (Misspelling)

Diagnostic characters: Head and thorax brownish-white. Labial palpi with 2nd joint less than 2x the length of 3rd. Frons conical with a corneous point and with a small ventral ridge. Fore wing variable from straw coloured to yellow-brown with scattered small dark brown specks all over the wing, casually forming small patches; medial line brown, oblique and reduced; submarginal line feeble; marginal line with a series of dark brown spots; cilia lighter colour distally. Hind wing whitish with brown shade near the costa and apex; cilia uniformally whitish (Plate 7, figs. 86, 87, 88; Plate 19, fig. 231; Plate 21, figs. 261, 262, 263).

Neuration:

Fore wing: Sc reaching costal margin at three-fifths length of wing; R_1 from cell at three-fifths of its length and reaching costal margin at two- thirds of length of wing; R_2 separate and arising from before end of cell and reaching at costal margin at half of length from end of cell to apex of wing; R_3 and R_4 stalked; R_3 from R_4 at nearly half of the distance from end of cell to apex of wing; R_4 reaching to apex; R_5 separate and basally close to M_1 and diverging distally; M_2 and M_3 close basally, diverging distally; Cu_1 distant basally from M_3; Cu_2 from cell at more than two-thirds of its length; 2nd A reaching margin; 3rd A incomplete (Plate 3, fig. 31).

Hind wing: $Sc+R_1$ reaching costal margin at near to apex of wing; Rs just after its origin from near upper angle of cell, anastomose with $Sc+R_1$ up to two-thirds distance from end of cell to apex of wing, then separated and reaching to apex; M_1 from upper angle of cell; M_2 and M_3 close basally, diverging distally; Cu_1 relatively distant from M_3 basally; Cu_2 from cell at three-fourths of its length; 1st A, 2nd A and 3rd A complete (Plate 3, figs. 32).

Genitalia:

Male: Uncus very long, triangular, beak shaped, sharply pointed at apex, with a few short setae. Gnathos shorter than uncus, more acute at apex, without setae. Valva with costal margin slighlty convex in the middle; apex pointed. Vinculum long with U-shaped saccus. Aedeagus long and bifurcate; cornutus absent (Plate 11, figs. 159, 160, 161).

Female: Papillae anales funnel shaped and setose. Anterior apophyses longer than the posterior. Ductus bursae very long and narrow, uniformly but weakly chitinized. Bursa copulatix large; signum distinct, elongate with median ridge (Plate 11, fig. 206).

Length: 11-15 mm

Wing span: 13-32 mm

Material examined: <u>BIHAR:</u> 1 ex., 14. III. 1914, 1 ex., 18. III. 1914, 1 ex., 3. X. 1917, 1 ex., 5. X. 1917, (Figured), 1 ex., 8. X. 1917 (Figured), 3 exs., 17. X. 1917, (one figured), 1 ex., 18. 10. 1917, 1 ex., 21. X. 1917, 2 exs., 23. X. 1917, 1 ex., 25.

X. 1917, 1 ex., 13. I. 1918, 2 exs., 5, 20. I. 1918, 1 ex., 20. II. 1918, 1 ex., 9. III. 1918, 3 exs., 12. III. 1918, 2 exs., 13, 18 . III. 1918, 1 ex., 2. IV. 1918, no Coll.; (all from Pusa), all *on rice stems and rice stubbles,* (labelled as *Chilo Oryzae* Fletcher). **[NPC]**

Distribution: Australia, Azerbaijan, Bangladesh, Bhutan, China, France, Hawaii, Throughout India, Indonesia, Iran, Italy, Japan, Kampuchea, Korea, Laos, Malaysia, Mynmar, Nepal, Pakistan, Papua New Guinea, Philippines, Siberia, Spain, Sri Lanka, Taiwan, Thailand, Turkey, Vietnam.

Chilotraea Kapur

Kapur 1950, *Trans. R. ent. Soc.* London, **101**(Pt.11): 402

(Type species : *Chilo infuscatellus* Snellen)

Diagnostic characters: This genus is charactorized by the same characters as that of *Chilo* Zincken but differ from it by the following characters: -

Frons produced forward, subrounded, usually smooth and without a corneous point. Forewing with veins R_1 and Sc confluent.

This genus has 4 species from India, of which 3 species are associated with rice. A dichotomous key is given below to differentiate them: -

Key to the species of *Chilotraea*

1. Fore wing deep straw-coloured to light fuscous; metallic scales and spots absent; a pair of discocellular blackish spots and a subterminal pale line or a series of spots; terminal series of small black spots, with minute white spots on inner side; cilia malt, with two dark lines----------------------*C. infuscatellus* (Snellen)

Fore wing straw coloured; irrirated with ochreous brown to fuscous; metallic scales and spots present; terminal series of spots either ill defined or absent; cilia shiny--2

2. Fore wing with dark metallic spots in the cell, at the origin of M_2, M_3 and one below the origin of Cu_1 extending to below Cu_2; a few metallic scales in and beyond the cell; a subterminal series of darker, metallic spots; cilia golden --*C. auricilia* (Dudgeon)

- Fore wing with discal dots reduced; subterminal line ill defined white, with a few silvery scales; cilia glossy ---------------------------*C. polychrysa* (Meyrick)

Chilotraea auricilia (Dudgeon)

Dudgeon 1905, *J. Bomb.nat. Hist.Soc.*, **16**: 405

Chilo auricilia Dudgeon 1905, *J. Bomb.nat.Hist. Soc.* , **16** : 405

Diatraea auricilia (Dudgeon); Fletcher 1928, *Sci. Rep. Agr. Res. Instt.* Pusa, 1926/27: 59

Chilotarea auricilia (Dudgeon); Kapur 1950, *Trans. R. ent. Soc.* London, **101**(Pt.11): 403

Chilo auricillius Dudgeon; Bleszynski and Collins 1962, *Acta zool. cracov.*, **7** : 239

Chilotraea auricilia (Dudgeon); Arora 2000, *Rec. zool. Surv. India,* Occasional Paper No. .181: 35

Chilo popescugorji Bleszynski 1963, *Acta zool. cracov.*, **8**: 179 (Synonymised by Bleszynski 1970)

Diagnostic characters: Head and thorax straw-coloured irrorated with fuscous. Labial palpi ochreous but suffused dark brown. Frons produced forward, subrounded and usually smooth at apex; apex sometimes with conical point which is not corneous. Antennae with dark and whitish brown ring. Hind legs with outer tibial spurs longer than inner. Fore wing brown ochreous irrorated with fuscous; five metallic spots with golden scales in a regular curve over the rufous band; few metallic scales in and beyond the cell; a submarginal series of darker spots incurved towards the costa; a marginal series of small and ill-defined black spots; cilia golden. Hind wing ochreous to dark grey; cilia silvery (Plate 7, figs. 89, 90, 91; Plate 19, fig. 232; Plate 21, figs. 264, 265, 266).

Neuration

***Fore wing*:** Sc reaching costal margin at three-fifths length of wing; R_1 from cell at more than two-thirds of its length and confluent with Sc for a short distant and then separate; R_2 separate from R_{3+4} and arising from some distance before upper angle of cell; R_3 and R_4 stalked; R_3 from R_4 at about half of distance from end of cell to apex of wing; R_5 close to M_1 and R_{3+4} basally, diverging distally. M_2 and M_3 close basally and diverging distally; Cu_1 distant from M_3; Cu_2 from cell at three-fifths of its length; 2nd A complete and reaching to margin; 3rd A incomplete (Plate 3, fig. 33).

***Hind wing*:** $Sc+R_1$ reaching to costal margin at near to apex of wing; Rs just after originating anastomose with $Sc+R_1$ up to two-thirds length of wing, then separated and reaching to apex of wing, M_1 from upper angle of cell; M_2 and M_3 close basally, diverging distally; Cu_1 distant from M_3 ; Cu_2 from cell at about two-thirds of its length; 1st A, 2nd A and 3rd A complete (Plate 3, figs. 34).

Genitalia

***Male*:** Uncus beak-shaped. Gnathos beak-shaped and shorter than uncus. Valva without parsbasalis; costal margin slightly bent; apical margin blunt. Vinculum V-shaped. Saccus long. Aedeagus long and narrow, divided at most of its length; cornutus absent (Plate 12, figs. 162, 163, 164).

***Female*:** Papillae anales funnel-shaped and profusely hairy . Anterior apophyses longer than posterior. Ductus bursae narrow and poorly sclerotized. Corpus bursae, narrow long, subrounded and almost equal to ductus bursae; signum absent (Plate 7, figs. 207).

Length: 9-17 mm

Wing span:15-31 mm

Material examined: ASSAM: 1 ex., 7. VIII. 1909, Rangpur, on rice, no Coll.; 1 ex.; 12. X. 1928, Tinsukia, BIHAR: 3 exs., -. III. 1903, 4 ex., -. -. 1904, Saran, all Mackenzie Coll.; 2 exs., 9. III. 1905, Dalsing Sarai, *on cane,* no Coll.; 1 ex., 15. VI. 1910, 2 exs., 6, 9. VII. 1910, 1 ex., 5. IX. 1910, 1 ex., 1. VII. 1911, 1 ex., 1. IX. 1916,(all from Pusa), all T.B.F. Coll.; 1 ex., 20. II. 1918, 1 ex., 26. VII. 1918, *on rice,* 1 ex., 3. VIII. 1918, 2 exs., 4, 9. VIII. 1918, 1 ex., 22. X. 1918, *on sugarcane,* (all from Pusa), no Coll.; 1 ex., 28. XI. 1917, Karimganj, *on rice stem,* W. Mekey Coll.; PUNJAB: 3 exs., 28.II. 1907, 1 ex., 13. III. 1907, Rajapatti, all *on sugarcane,* no Coll. **[NPC]**

Distribution: Bangladesh, Bhutan, China, Hong Kong, Throughout India, Indonesia, Malayasia, Myanmar, Nepal, Philippines, Sri Lanka, Taiwan, Thailand, Vietnam.

Chilotraea infuscatellus (Snellen)

Snellen 1890[b]. *Meded Profestn. Suik Riet W. Java Kagok*, 94.

Chilo infuscatellus Snellen 1890[b], *Meded. Profestn. Suik Riet W. Java Kagok,* 94

Chilotraea infuscatellus (Snellen); Kapur 1950, *Trans. R. ent. Soc.* Lond., **101**(11): 404

Chilo infuscatellus (Snellen); Bleszynski 1962[b], *Acta zool. cracov.*, 7 : 111

Chilotraea infuscatellus (Snellen) ; Arora 2000, *Rec. zool. Surv : India*, Occasional Paper, No. 181 :29

Argyria sticticraspis Hampson 1919[b], *Ann. Mag. nat. Hist.*, (s.9) **3** : 449 (Synonymised by Kapur 1950)

Argyria coniorta Hampson 1919[b], *Ann. Mag. nat. Hist.*, (s.9) **3**: 449. (Synonymised by Fletcher 1928)

Diatraea calamina Hampson 1919[b], *Ann. Mag. nat. Hist.*, (s.9) **3** : 544 (Synonymised by Kapur 1950)

Diatraea shariinensis Eguchi 1933. *J. agric. Exp. Stn. Chosen*, **19** : 3 (Synonymised by Kapur 1950)

Chilo tadzhikiellus Gerasimov 1949, *Trudy zool. Inst. Leningr.*, **8** : 704 (Synonymised by Bleszynski 1962)

Diagnostic characters: Head and thorax fuscous. Frons produced forward, rounded and without a trace of corneous point. Antennae with dark and whitish brown ring. Legs with outer tribial spurs of middle leg half of the length of inner ones whereas in hind leg it is two thirds. Fore wing deep straw coloured to light fuscous but without metallic spots, with a pair of discoidal blackish spots, the lower spot being defined on outer side by white; subterminal line pale fuscous or with a series of spots, sometimes mixed with whitish scales; terminal line with a series of minute black spots defined on inner side by minute white spots; cilia straw coloured with two darker lines. Hind wing dirty white to silky white; cilia light yellow (Plate 7, figs. 92, 93, 94; Plate 19, fig. 233; Plate 21, figs. 267, 268)

Neuration

Fore wing: Sc reaching costal margin at more than two-thirds length of wing; R_1 from cell at about two-thirds of its length and anastomising with Sc; R_2 from upper angle of cell and reaching costal margin at half of length from end of cell to apex of wing; R_3 and R_4 stalked; R_3 from R_4 at less than half of its length; R_5 and M_1 close basally, diverging distally; M_2 and M_3 very close basally from lower angle of cell diverging distally; Cu_1 distant basally from M_3; Cu_2 from cell at about two-thirds of its length; 2nd A complete and reaching margin; 3rd A short and weak (Plate 3, fig. 35).

Hind wing: Sc+R_1 reaching costal margin at about five-sixth length of wing; Rs just after its origin, anastomose with Sc+R_1 up to two-thirds length of wing, then separated and reaching apex; M_1 from upper angle of cell; M_2 and M_3 close basally, diverging distally; Cu_1 distant basally from M_3; Cu_2 from cell at two-thirds of its length; 1st A, 2nd A and 3rd A complete (Plate 3, fig. 36)

Genitalia

Male: Uncus short, triangular, beak-like and pointed at tip. Gnathos as long as uncus and sclerotized. Valva with pars basalis; costal margin slightly bent towards base; apical margin blunt. Vinculum small, V-shaped, flat, heavily sclerotized and not produced apically. Saccus short. Aedeagus undivided and slightly bent; cornutus single, elongate and well sclerotized (Plate 12, figs. 165, 166, 167).

Female: Papillae anales oval, profusely armed with setae. Anterior apophyses longer than posterior. Ductus bursae long, narrow, slightly sclerotized and more or less equal to the size of corpus bursae. Corpus bursae subglobular to oval; signum present near the joint of ductus bursae and corpus bursae, lamellate with median ridge (Plate 16, fig. 208).

Length: 10-19 mm

Wing span: 20-34 mm

Material examined: BIHAR: 1 ex., 31. VIII. 1916, *on sugarcane* , D. Nandan Coll.; 2 exs., 22. VII. 1920, 1 ex., 19. 7. 1920, *on sugarcane,* Rangi Coll.; 1 ex., 22. VII. 1916. *on sugarcane,* D. Nandan Coll.; 1 ex., 20. V. 1906. D. R. Coll.; 19. VII. 1910, D. Nanda, all *on sugarcane;* 1 ex., 24. III. 1916, D. Nandan Coll.; 1 ex., 20. VII. 1916, no Coll.; 1 ex., 9. VI. 1931, *Sacchrum fuscum, Rangi* Coll.; 1 ex., 19. VI. 1915, *on maize,* D. P. S. Coll.; 1 ex., 30. VI. 1916, H Singh Coll.; 1 ex., 21.II. 1931, Rangi Coll.; 2 ex., 8, 3. VII. 1914, R.S. Coll.; 1 ex., 10. VIII. 1914, no Coll.; 1 ex., 8. VII. 1914, R. S. Coll.; 1 ex., 8. VII. 15, D. P. S. Coll.; ORISSA: 1 ex., 9. V. 1906, 1 ex., -. IV. 1906, all *on sugarcane,* Cuttack, D. N. P. Coll.; PUNJAB: 3 exs.; 4, 6, 30, 11. VII. 1914, *on sugarcane*, Lyalpur, A. J. G. Coll.; 1 ex., 29. VII. 1914, *on Sugarcane,* Gurdaspur, UTTARPRADESH: 1 ex., 3. IX. 1914, 1 ex., 16. VIII. 1914, *on sugarcane,* Cawnpur E.S. David Col. **[NPC]**

Distribution: Afghanistan, Upper Myanmar, Throughout India, Indonesia, Korea, Malayasia, Papua New Guinea, Philippines,Tadzakistan, Taiwan, Vulcan Island.

Chilotraea polychrysa (Meyrick)

Meyrick 1932, *Exotic Microlepidopetra*, **4** : 321

Diatraea polychrysa Meyrick 1932, *Exotic Microlepidoptera*, **4** : 321

Chilotraea polychrysa (Meyrick); Martin 1954, *Entomologist,* London, **87** : 120

Proceras polyshrysa (Meyrick); Nair 1959, *Curr. Sci.*, **26** (3): 92-93

Chilotraea polychrysa (Meyrick); Israel, Murthy and Rao 1961, *Rice News Letter*, **9** (2): 23-26

Chilo polychrysus (Meyrick); Bleszynski 1962, *Acta zool. carcov.*, **7** : 115

Chilo polychrysus (Meyrick): Bleszynski 1970, *Bull. Brit. Mus. (Nat. Hist.), Entomology*, **25** (4) : 140

Chilotraea polychrysa (Meyrick): Arora 2000, *Rec. zool. Surv. India.* Occasional Paper No. 181 : 140

This species could not be studied because of non-availability of specimens (Plate 22, fig. 268a).

General Distribution: China, India (Assam, Kerala, Tamil Nadu, West Bengal), Indonesia, Laos, Malaysia, Myanmar, Pakistan, Philippines, Thailand, Vietnam

Subfamily Nymphulinae

Diagnostic characters: Head with frons smoothly rounded and less prominent. Proboscis moderate to well developed. Labial palpi upturned, Ocelli well developed, small or absent. Fore wing with vein R_2 generally stalked with R_{3+4}. Hind wing without pectination on upper side of median vein.

Only one genus have been examined under this subfamily.

Parapoynx Huebner

Huebner 1825, *Verz. Bekant. Schmett.*, p. 362

Paraponyx Guenee 1854, *Delt. et. Pyral.*, **8**: 274 (Misspelling)

Eustales Clemens 1860, *Proc. Acad. nat. Sci Phild.*, p. 216 (Synonymised by Speidel 1984)

Sironia Clemens 1860, *Proc. Akad. nat. Sci. Philad.*, p. 218 (Synonymised by Speidel 1984)

Nymphaeela Grote 1880, *N. Am. Ent.* **1**: 97 (Synonymised by Speidel 1984)

Hydreuretis Meyrick 1885, *Trans. ent. Soc.* Lond. p., 435 (Synonymised by Shaffer *et al.* 1996)

Microdracon Warren 1890, *Ann. Mag. nat. Hist.*, (s.6) **6** : 478 (Synonymised by Shaffer *et. al.* 1996)

Cosmophylla Turner 1905, *Trans. Roy. Soc. S. Australia*, **32** : 85 (Synonymised by Shaffer *et. al.* 1996)

(Type species: *Phalaena stratiotata* Linnaeus)

Diagnostic characters: Labial palpi slightly ascending and upturned; 2nd joint moderately fringed with hairs; 3rd joint short, lanceolate. Maxillary palpi long and dilated with scales at distal end. Antennae stout, annulated and minutely pubescent. Legs very long and slender; tibial spurs of hind legs slender and almost equal. Fore wing with the cell more than half of its length; veins Cu_1, M_3 and M_2 from lower angle of cell; vein R_5 well separated; veins R_{2+3+4} generally stalked but sometimes R_2 free. Hind wing with the cell about half of its length; Cu_1 , M_3 and M_2 from lower angle of cell; M_1 and R_5 from upper angle of cell; R_5 strongly anastomising with $Sc+R_1$.

This genus has 6 species from India, of which two species namely *P. fluctuosalis* and *P. stagnalis* are reported as a pest of rice in India. These can be separated by the following key: -

Key to the species of *Parapoynx*

1. Fore wing narrow with vein R_2 free ------------------ *P. fluctuosalis* (Zeller)

- Fore wing and hind wing narrow with vein R_2 stalked with R_{3+4}---------------------------------*P. stagnalis* (Zeller)

Parapoynx fluctuosalis (Zeller)

Zeller 1852, *Lep. Microp. Caffr.*, p. 27

Paraponyx fluctuosalis (Zeller); Hampson 1891, *Ill. Typ. Spec. Lep. Het. Brit. Mus.*, **8** : 40

Nymphula fluctuosalis (Zeller); Hampson 1896, *Faun. Brit. Ind. Moths*, **4** (1): 193

Parapoynx flutctuosalis (Zeller); Speidel 1984, *Neue Entomologische Nachrichten*, **12** : 84

Paraponyx linealis Guenee 1954, *Delt. et. Pyral.*, p. 271 (Synonymised by Speidel 1984)

Oligostigma chrysippusalis Walker 1859[a], *List. Spec. Lep. Ins. Coll. Brit. Mus.*, **17** : 432 (Synonymised by Speidel 1984)

Oligostigma obitalis Walker 1859[a], *List. Spec. Lep. Ins. Coll. Brit. Mus.*, **17** : 432 (Synonymised by Speidel 1984)

Oligostigma curta Butler 1879, *Ent. Mon. Mag.*, **15** : 270 (Synonymised by Speidel 1984)

Nymphula luteivittalis Mabille 1880, *C. R. Soc. Ent. Belg.*, **23**: 29 (Synonymised by Speidel 1984)

Paraponyx oryzalis Wood-Mason 1885, Rice pests of Burma, Calcutta. C&S No. 4400. (Synonymised by Speidel 1984)

Diagnostic characters: Head and thorax white, irrorated with black. Abdomen white with broad black-edged bands. Fore wing white; costal area tinged with fulvous; subbasal band black and oblique; antemedial band black and oblique; an indistinct fulvous spot in the cell; upper angle of cell with a black spot; an oblique black, curved band from the costa near the apex to lower angle of cell, then straight . Hind wing with an oblique subbasal line from cell to inner margin. Both wings with a slightly curved oblique black-edged postmedial band; a black line near margin ; a fulvous marginal band and a black line at base of cilia (Plate 7, figs. 95, 96, 97; Plate 19, fig. 234; Plate 22, figs. 269, 270, 271).

Neuration

Fore wing: Sc reaching costal margin at more than half of the length of wing; R_1 from cell at five-sixths distance of its length, reaching costal margin at about two- thirds length of wing; R_2 free reaching apex; R_{3+4} stalked; R_3 from R_4 at two-thirds distance of its length; R_4 reaching apex; R_5 from upper angle of cell and more close to R_{3+4} than M_1; M_1 from upper angle of cell and quite apart from M_2 but running almost parallel towards margin; M_2, M_3 and Cu_1 close basally, diverging distally: Cu_2 from cell at five-sixths distance of its length; 2^{nd} A reaching margin (Plate 4, fig. 37).

Hind wing: $Sc+R_1$ running closely parallel to costal margin, anastomosing with Rs beyond cell, separately at five-sixth length of wing and $Sc+R_1$ just touching costal margin ; Rs reaching apex; M_1 from upper angle of cell and diverging distally; M_2 and M_3 very close basally, diverging distally; Cu_1 shortly distant; Cu_2 from cell at about two-thirds distance of its length; 1^{st} A, 2^{nd} A and 3^{rd} A present (Plate 4, fig. 38).

Genitalia

Male: Uncus narrow, without hairs. Gnathos well developed, length equal to uncus. Vinculum short, rather broad. Saccus slightly developed. Valva rounded, slightly narrow at base; costal margin sclerotized, setose; apical margin setose. Aedeagus slender; cornutus absent (Plate 12, figs. 168, 169, 170).

Female: Papillae anales funnel shaped, setose. Anterior apophyses longer than posterior apophyses. Ductus bursae very long memberanous. Corpus bursae semiglobular; signum absent (Plate 16, fig. 209).

Length: 5-8 mm

Wing span: 11-18 mm

Material examined: S. ANDAMAN: 1 ex., - . VIII. 1927, Ferrar Coll.; ASSAM : 1 ex. 26. X. 1921, at light, Sibsagar, C.C. G. Coll.; BIHAR: 2 exs., 15. VIII. 1905, Patonganj, C.S.M. Coll.; 4 exs.-. IX. 1906, 1 exs., -. X. 1906, Palamau, All A.M. Coll.; 2 exs., 28 . VIII. 1925, Daltonganj, Haq Coll.; 1 ex., 16.X. 1911, at light, Katihar, C.C.G. Coll.; 1 ex., 31. VII. 1908, R. D. D. Coll.; 1 ex., 8. VIII. 1914, 1 ex., 27. X. 1914, on weeds, R.S. Coll.; 1 ex., 9. XII. 1914, 1 ex., 9 III. 1915, 1 ex., 21. IV. 1915, 1 ex., 5. V. 1915, 2 exs., 4. IX. 1915, 1 ex., 20. IX. 1915, 1 ex., 27 .IX. 1915, all Boy Coll.; 1 ex. 12. VII. 1911, 2 exs., 15, 16. III. 1915, T.B.F. Coll.; 1 ex., 1. VII. 1915, D. Nandam Coll.; 3 exs., 1. IX. 1915, 2 exs., 7, 24. IX. 1915, U. Bahadur Coll. (all from Pusa). MADHYA PRADESH: 2 exs., -. II. 1907, 1 ex., -. III. 1907, Katni, A. M. Coll.; MEGHALAYA: 3 exs., 8, 26, 27. IV. 1928, 2 exs., 28. VI. 1928, Shillong, A. G. R. Coll.; 2 exs no more data. ORISSA: 1 exs., - . VIII. 1906, 1 ex.,-. X. 1906, 1 ex.,-. III. 1907, Cuttack, A. M. Coll.; 1 ex., 6. III. 1945, at light, Bose Coll.; Cuttack; 1 ex., 23. X. 1906, 1 ex., -. X. 1906, A.M.Coll.; Bhadrak, TAMIL NADU: 1 ex. 12. III. 1913, 1 ex. 20. IX. 1913, at light, Coimbatore, A. G. C. Coll.; 1 ex., -. VIII. 1921, 2 ex., 19, 27. VIII. 1929, 1 ex., 13. X. 1929, all Palnis, Kodaikanal, Fletcher Coll; WEST BENGAL: 4 exs., no more, data Kalimpong, Lindgren Coll.; 1 ex., no more date, Darjilling, Mackenzie Coll.; 1 ex -. IX. 1907, Purulia, A.M. Coll.; 2 ex., 12. XI. 1924, Calcutta, S. Mukherjee Coll. **[NPC]**

Distribution: Africa, Australia, Bangaladesh, Bhutan, China, Formosa, Hawaii, Throughout India , Indonesia, Japan, Myanmar, Pakistan, Philippines, Sri Lanka, Tonkin,

Parapoynx stagnalis (Zeller)

Zeller 1852, *Lep. Microp. Caffr.*, p. 26

Parapoynx stagnalis (Zeller); Lederer 1863, *Z. Wien. ent. Monat.*, 7 : 452

Hydrocampa depunctalis Guenee 1854, *Delt. et. Pyral.*, p. 274. (Synonymised by Speidel 1984)

Zebronia decussalis Walker 1859[a], *List. Spec. Lep. Ins. Coll. Brit. Mus.* , **17** : 481. (Synonymised by Speidel 1984)

Cataclysta vestigialis Snellen 1880[a], *Trans. ent. Soc.* Lond., p. 628. (Synonymised by Speidel 1984)

Hydrocampa hilli Tepper 1890, *Common native insects of south Australia. A popular guide to South Australian Entomology* 2 pts-Adelaide. Part II Lepidoptera, or butterflies and moths. pp. i-iv, 1-65 (Synonymised by Speidel 1984)

Diagnostic characters: Head, thorax and abdomen pure white. Fore wing with costa dark, antemedial band very pale, ochreous-yellow; a short oblique band from costa before the apex; a submarginal lunular line; a marginal lunular as well as slender line; two black dots corresponding to orbicular and reniform marks. Hind wing with dark discocellular speck; medial and postmedial bands fulvous, interrupted; marginal line lunular as well as slender with a series of specks (Plate 7, figs. 98, 99, 100; Plate 19, fig. 235; Plate 22, figs. 272, 273, 274, 275).

Neuration

Fore wing: Sc reaching costal margin at less than two-thirds length of wing; R_1 from just before upper angle of cell, reaching costal margin at two-thirds length of wing; R_{2+3+4} stalked; R_2 from R_{3-4} at about one-thirds distance of its length, reaching costal margin at about four-fifths length of wing; R_3 from R_4 at two-thirds distance of its length; R_5 free and very close to R_{2+3+4} basally, diverging distally; M_1 quite apart from M_2; M_2, M_3 and Cu_1 close basally, diverging distally; Cu_2 from cell at five-sixths distance of its length and parallel towards inner margin. 2nd A reaching margin (Plate 4, fig. 39).

Hind wing: Sc+R_1 reaching to costal margin at about two-thirds length of wing; R_s after its origin, anastomose with Sc+R_1 up to three-fourths length of wing, then separated and reaching to apex: M_1 from upper angle of cell and anastomising with the stem of Sc+R_1+Rs just after its origin at a point, then diverging; M_2, M_3 and Cu_1 from lower angle of cell, close basally and diverging distally; Cu_2 from cell at two-thirds distance of its length; 1st A, 2nd A and 3rd A complete (Plate 4, fig. 40).

Genitalia

Male: Uncus long and spoon shaped. Gnathos prominent and slightly shorter than uncus. Vinculum well developed produced anteriorly into a short U-shaped saccus. Valva long and rectangular; costal margin and saccular margin almost parallel to each other; apical margin straight with hairs. Aedeagus long and broad; cornutus absent (Plate 12, figs. 71, 72).

Female: Palillae anales with long and short setae. Anterior apophyses as long as posterior apophyses. Ductus bursae long and completely membranous. Corpus bursae more or less bulb-shaped and membranous; signum oblong (Plate 16, fig. 210).

Length: 6-7 mm

Wing span: 12-18 mm

Material examined: ANDAMANS: 1 ex., -. VII. 1927, Ferrar Coll.; ASSAM: 1 ex., -. IV. 1908, at light, Gauhati, A.M. Coll.; 1 ex., 29. X. 1911, at light, Naokhali, C.C.G. Coll.; 1 ex., 24. X. 1911, at light, Lumding, C.C.G. Coll.; 2 exs., 16 .X. 1928, at light, Dilbrugarh, Bose Coll.; BIHAR: 1 ex., -. X. 1907, A. Mujtaba Coll.; 1 ex., 12. IX. 1910, I ex., 8. VIII. 1912, 1 ex., 29. X. 1927, all Fletcher Coll.; 1 ex., 23 .IX. 1914, 2ex., 25. IX. 1914, all without Coll.; 1 ex., 3. XI. 1914, Boy Coll.; [All from Pusa]; KARNATAKA: 2 exs., 18, 22. IV. 1915 S. Canara, Manglore C. R. Dutt Coll; , KERALA: 1 ex ., 23. XI. 1908, *on paddy*, Hurumbranad, Y. R. Coll.; MAHARSHTRA: 1 exs., -. X. 1909, Bombay, Bassein Fort, A. M. Coll.; MEGHALAYA: 2 exs., -. X. 1916, Cherrapunji, Native Coll.; TAMIL NADU: 1 ex., 16. XI. 1908, *on paddy*, Coimbatore, T. V.R. Coll.; 2 exs., 15. I. 1913, A. G. R. Coll.; WEST BENGAL : 3 exs., -. IX. 1907, Chakradharpur, A. M. Coll.; 12 exs., - . IX. 1907, Purulia, A. M. Coll.; 2 ex.; 1-7.IX. 1921, Calcutta, Fletcher Coll. **[NPC]**

Distribution: Australia, Bangaladesh, Bhutan, Brazil, Cameroon, China, Dutch East Indies, Ghana, Throughout India, Indonesia, Japan, Kampuchea, Laos, Latin America, Madagascar, Malawi, Malaysia, Mauritius, Mozambique, Myanmar, Nepal, New Guinea, Nigeria, Pakistan, Philippines, Sri Lanka, Taiwan, Thailand, Uruguay, USA, Venezuela, Vietnam, Zaire, Zambia.

Subfamily Pyraustinae

Diagnostic characters: Head with frons flat, oblique or rounded. Labial palpi porrect or upturned. Proboscis well developed. Fore wing with R_5 free; 3rd A generally present but sometimes absent, if present, then short and curved upwards towards 2nd A. Hind wing with median veins without pectination on upper side.

Seven genera could be examined under this subfamily which can be recognized by the following key:

Key to the genera of Pyraustinae

1. Fore wing with vein R_2 stalked with R_{3+4}---2
- Fore wing with vein R_2 free from R_{3+4}---3
2. Labial palpi upturned --- *Bradina* Lederer
- Labial palpi porrect ---*Mabra* Moore
3. Labial palpi with 3rd segment naked---4
- Labial palpi with 3rd segment covered with scales-------------------------------------5
4. Fore wing with vein R_5 nearly straight and well separated from R_{3+4} ----------------
--- *Notarcha* Meyrick
- Fore wing with vein R_5 curved and closely approximated to R_{3+4} ---------------------
---*Pleuroptya* Meyrick
5. Hind wing with Rs anastomosing with $Sc+R_1$ up to most of its length -------------
-- *Cnaphalocrocis* Lederer
- Hind wing with Rs anastomosing with $Sc+R_1$ up to two-thirds of its length---------6
6. Hind wing with veins M_2 and M_3 approximated basally for a short distance ---------
-- *Herpetogramma* Lederer
- Hind wing with veins M_2 and M_3 not approximated basally ---------------------------
--- *Crypsiptya* Meyrick

Bradina Lederer

Lederer 1863, *Z. Wien. ent. Monat.*, **7**: 424

Erilita Lederer 1863, *Z. Wien. ent. Monat.*, **7** : 426. (Synonymised by Hampson 1896)

Pleonectusa Lederer 1863, *Z. Wien. ent, Monat.*, **7** : 426 (Synonymised by Hampson 1896)

Trematarcha Meyrick 1886, *Trans. ent. Soc.* Lond., p. 233. (Synonymised by Shibuya 1928-29)

(Types species : *Bradina impressalis* Lederer.)

Diagnostic characters: Labial palpi upturned; 2nd joint long with scales in front; 3rd joint short and cylindrical. Maxillary palpi as long as labial palpi. Legs long, slender; hind tibiae with outer spurs about half of inner spurs. Fore wing with veins Cu_1, M_3 and M_2 from lower angle of cell; R_5 straight and well separated from R_{2+3+4}; R_{2+3+4} stalked. Hind wing with veins Cu_1, M_3, M_2 from lower angle of cell; vein M_1 from upper angle of cell; $Sc+R_1$and Rs anastomosing beyond cell.

This genus has 6 species from India, of which *Bradina admixtalis* (Walker) is reported on rice crop.

Bradina admixtalis (Walker)

Walker 1859[b], *List Spec. Lep. Ins. Coll. Brit. Mus.*, **18**: 665

Botys admixtalis Walker 1859[b], *List Spec. Lep. Ins. Coll. Brit. Mus.*, **18**: 665

Pleonectusa admixtalis (Walker); Lederer 1863, *Z. Wien. ent. Monat.*, **7** : 426

Bradina admixtalis (Walker); Hampson 1896, *Faun. Brit. Ind. Moths.*, 4 (1) : 227

Botys panaeusalis Walker 1859[c], *List.Spec. Lep. Ins. Coll. Brit. Mus.*, **19**: 998 (Synonymised by Hampson 1896)

Pleonectusa tabidalis Lederers 1863, *Z. Wien. ent. Monat.*, **7** : 426. (Synonymised by Hampson 1896)

Pleonectusa sodalis Lederer 1863., *Z. Wien. ent. Monat.*, **7**: 481 (Synonymised by Hampson 1896)

Botys leptogastralis Walker 1865, *List. Spec. Lep. Ins. Coll. Brit. Mus.*, **34** : 1432 (Synonymised by Shibuya 1928-29)

Spoladea avunculalis Saalmueller 1880, *Senckenb. Naturf Ges.*, p. 297. (Synonymised by Shaffer *et al.*, 1996)

Pleonectusa pallidalis Warren 1896[a], *Ann. Mag. nat. Hist.*, (s.6) **17** : 147 (Synonymised by Hampson 1896)

Diagnostic Characters: Body cinereous and shining white below. Labial palpi brown, moderately broad and white beneath. Fore wing narrow with dark speck in the cell; discocellular lunule present; postmedial line dark brown and curved ; marginal line dark brown; cilia whitish and its base dark brown. Hind wing broader than fore wing, iridescent, slightly curved; postmedial line curved and dark brown; marginal line dark brown; cilia whitish (Plate 8, figs. 101, 102, 103; Plate 19, fig. 236; Plate 23, figs. 276, 277).

Neuration

Fore wing: Sc reaching costal margin at two-thirds length of wing; R_1 from cell at three-fourths of its length; R_{2+3+4} stalked; R_2 from R_{3+4} at two-fifths distance from the end of cell to apex of wing; R_3 from R_4 at three-fifths distance from end of cell to apex of wings; R_4 reaching to apex; R_5 close basally to R_{2+3+4}, diverging distally; M_1 close to R_5 basally, near about parallel distally; M_2, M_3 and Cu_1 close and about equidistant basally, diverging distally; Cu_2 from cell at three-fourths of its length; 2[nd] A reaching to margin (Plate 4, fig. 41,).

***Hind wing*:** $Sc+R_1$ reaching to costal margin at near to apex of wing; Rs just after its origin, anastomose with Sc+R1 up to two-thirds of the length of wing, then separated and reaching apex; M_1 anastomosing with $Sc+R_1$ for short distance beyond the upper angle of cell; M_2, M_3 and Cu_1 close and equidistant basally; M_2 and M_3 diverging distally; M_3 and Cu_1 near about parallel distally; Cu_2 from cell at two-thirds length of cell; 1st A , 2^{nd} A and 3^{rd} A complete (Plate 4, fig. 42).

Genitalia

Male: Uncus moderately long, broad at base, apex lobe like with tuft of hairs. Gnathos reduced and semimembranous. Vinculum rhomboidal and produced into a short saccus. Valva long, base narrow; costal margin excurved; apical margin bears long tuft of hairs. Aedeagus long narrow; distal portion swollen; cornutus present in form of a long sclerotized strap (Plate 12, figs. 173, 174).

Female: Papillae anales densely fringed with long and short hairs. Anterior apophyses almost double that of posterior apophyses. Dutctus bursae long and membrenous. Corpus bursae globate; signum cone shaped, well sclerotized (Plate 16, fig. 211).

Length: 10-15 mm

Wing span: 20-25 mm

Material examined: BIHAR: 1 ex., 22. IV-. *on grass*, Boy Coll.; 3 exs., 15. III. 1915, 1 ex., 17. III. 1915, I ex., 18. III. 1915, (all Boy Coll.); 2 exs., 3, 4. VII. 1915, Boy Coll.; 1 ex., 10. XII. 1914, 1 ex., 26. XI. 1914, Boy Coll.; 1 ex., 11. XI. 1929, E. Hassan Coll.; 1 ex., 30. VI. 1918, D. Nanda Coll.; 1 ex., 7. III. 1916, T. Ram Coll.; 10 exs., -. III. 1916, 2 exs., 1. III. 1916, I ex., 2. III. 1916, 2 exs., 9. III. 1916, 1 ex., 10. III. 1916 (all Boy Coll.); 1 ex., 12. VIII. 1915, *at light*, U. Bahadur Coll.; 2 exs., 19. III. 1907, B.S. Coll.; 1 ex., 4. III. 1907, G. D. O. Coll.; 1 ex., 27. VI. 1908, A. M. Coll.; 1 ex., 19. XI. 1914, 1 ex., 5. XII. 1915, Boy Coll.; 1 ex., 30. II. 1925, Bose Coll.; 1 ex., 27. IV. 1914, R. S. Coll.; 1 ex., 20. XI. 1908, A.M. Coll.; 1 ex., 12. VII. 1916, *at light*, D. Nandan Coll.; 1 ex., 9.V. 1914, R. S. Coll.; 1 ex., 13. VI. 1915, 1 ex., 15. XII. 1915, Boy Coll.; 1 ex., 22. II. 1924, Haq Coll.; I ex., 29. I. 1916, Boy Coll.; 1 ex., *at light*, U. Bahadur Coll.; 1 ex., 25. VI. 1915, Boy Coll.; 1 ex., 28. X. 1915, Boy Coll.; 1 ex., 14. X. 1910, T.B.F. Coll.; 1 ex., 29 .X. 1908, *at light*, G.D.R. Coll.; [all from pusa]; 1 ex., 25. VIII. 1922. Ranchi, Fletcher Coll.; NICOBAR: 7 exs., 22-26.

III. 1925, Mujtaba Coll.; 1 ex., 9-III. 1925, *on Mitha Khari*, Mujtaba Coll.; 5 exs., 22-26. III. 1925, P. V. Isaac Coll.; 1 ex., -. IV. 1908, Nowgon, A.M. Coll.; **[NPC]**

Distribution: Throughout India, Japan, Malaysia, Myanmar,South Africa, Perak, Sri Lanka, Taiwan

Cnaphalocrocis Lederer

Lederer 1863, *Z. Wien. ent. Monat.*, **7** : 384

Bradinomorpha Matsumura 1920, *Injur. Insects Japan. Emp.*, p 514 (Synonymised by Shaffer *et al.*, 1996)

Dolichosticha Meyrick 1884, *Trans. ent. Soc.* Lond., p. 304. (Synonymised by Shaffer *et al.*,1996)

Epimima Meyrick 1886, *Trans. ent. Soc.* Lond., p. 235. (Synonymised by Shaffer *et al.*,1996)

Lasiacme Warren 1896[b], *Ann. Mag. nat. Hist.*, (s. 6) **18** : 176 . (Synonymised by Shaffer *et al.*,1996)

Marasmia Lederer 1863, *Z. Wien. ent. Monat.*, **7** : 385. (Synonymised by Shaffer *et al.* 1996)

Neomarasmia Kalra, David and Banerjee, 1966. *Indian J. Ent.*, **28**(4): 554. (Nomen nudum for *Marasmia* Lederer). (cf. Shaffer *et al.*, 1996)

Prodotaula Meyrick 1931-35, *Exot. Microlepid.*, **4** : 15 (Synonymised by Shaffer *et. al.*, 1996)

Susumia Marumo 1930, *Oyo-Dobuts. Zasshi*, **2**:41 (Synonymised by Shaffer *et al.*,1996)

(Type species: *Salbia medinalis* Guenee)

Diagnostic characters: Labial palpi moderately long, straight, porrect; 2[nd] joint triangularly scaled in front ; 3[rd] joint short, blunt and slightly curved and with triangular tuft. Maxillary palpi moderate, dilated with loose scales towards apex, Frons flat and oblique. Antennae annulated. Legs long; hind tibiae with inner spurs more than twice the length of outer spurs. Fore wing with vein R_2 very closely approximated to R_{3+4} but sometimes stalked to R_1; R_5 slightly curved at base and then straight; M_1 from upper angle of cell; 2^{nd} A curved near the base and complete. Hind wing with Rs anastomosing with $Sc+R_1$ for almost entire length and bifurcate only near apex of wing; M_1 from upper angle; M_2, M_3 and Cu_1 from lower angle of cell .

This genus has 10 species from India, of which six species are reported as pest of rice. The present study could include only three species which can be separated by the following key:-

Key to the species of *Cnaphalocrocis* Lederer

1. Fore wing with R_1 and R_2 stalked--------------------*C. medinalis* (Gunee)
- Fore wing with R_1 and R_2 free-- **2**
2. Fore wing with R_2 separate from R_{3+4}--------------*C. poeyalis* (Boisduval)
- Fore wing with R_2 very closely approximated to R_{3+4}----------------------- **3**
3. Hind wing with 3 transverse lines------------------ *C. suspicalis* (Walker)
- Hind with 2 transverse lines---**4**
4. Wing slightly paler and expanse 21 mm----------*C. bilinealis* (Hampson)
- Wing not paler and expanse 15-18 mm---------------*C. patnalis* (Bradley)

Cnaphalocrocis medinalis (Guenee)

Guenee 1854, *Delt. et Pyral.*, p. 201

Salbia medinalis Guenee 1854, *Delt. et Pyral.*, p. 201

Cnaphalocrocis medinalis (Guenee); Lederer 1863, *Z. Wien. ent. Monat.*, 7: 384

Botys nurscialis Walker 1859_b, *List Spec. Ins. Coll. Brit. Mus.*, **18** : 724 .
(Synonymised by Shaffer *et al.*, 1996)

Diagnostic characters: Body ochreous- yellow. Labial palpi white below. Abdomen ringed with fuscous and white, anal tuft black with two white longitudinal streaks.

Fore wing with costal edge and a marginal cinereous-brown band; an outwardly oblique, slender, brown antemedial line; an inwardly oblique discal line; a slender brown lunule at end of cell; a blackish marginal line. Hind wing with a slender brown spot at end of cell; a discal line; a cinereous-brown marginal band and a blackish marginal line; cilia edged with white and with a brown inner line (Plate 8, figs. 104, 105, 106; Plate 19, fig.237; Plate 23, figs. 278, 279) .

Neuration

Fore wing: Sc reaching costal margin at two-thirds length of wing; R_1+R_2 stalked; R_{3+4} stalked; R_3 separated from R_4 at two-thirds distance from end of cell to apex of wing; R_5 separate; M_1 from upper angle of cell; M_2, M_3 and Cu_1 close basally, diverging distally; Cu_2 from cell at two-thirds of its length; 2^{nd} A reaching margin; 3^{rd} A present basally and curved upwards after a short distance towards 2^{nd} A (Plate 4, fig. 43).

Hind wing: Sc+R_1 anastomising with Rs for most of its length and separate near apex of wing; M_1 from upper angle of cell; M_2 , M_3 close basally and diverging distally; Cu_1 distant from M_3; Cu_2 from cell at about two-thirds of its length; 1^{st} A, 2^{nd} A and 3^{rd} A complete (Plate 4, fig. 44).

Genitalia

Male: Uncus short, oval, bifid, covered with short hairs. Gnathos thin, triangular and longer than uncus. Valva short and oval; costal margin poorly defined; apical margin fringed with scales.Vinculum with the saccus normal and V-shaped. Aedeagus short and slender; cornutus single and stout (Plate 12, figs. 175, 176).

Female: Papillae anales swollen and bearing setae. Anterior apophyses longer than posterior apophyses. Ductus bursae short and broad basally and narrow distally.Corpus bursae oblong and membranous; signum absent (Plate 16, fig. 212).

Length: 6-9 mm

Wing span: 15-20 mm

Material examined: ASSAM: 3 exs., 10. X. 1928, *at light,* Jorha, Bose Coll.; BIHAR: 2 exs., 14, 2, IX. 1934, *on paddy,* Rangi Coll.; 3 exs., 19, 20. XI. 1914, 4 exs., 22. IX. 1914, 1 ex., 27. X. 1914, 1 ex., 4. XII. 1914, 2 ex., 24. II, $. III. 1916, 1 ex., 9. III. 1915, (all from Pusa), all Boy Coll.; DELHI: 2 exs., 2. XI. 1949, *at light,* Bose Coll.; 7 exs., 30. IX. 1997, 6 exs., 22. IX. 1997, 7 exs., 5. X. 1997, *sweeping on paddy,* Z. H. Khan Coll.; 8 exs., 5. IX. 1998, *on paddy,* Z. H. Khan Coll.; EAST SIKKIM: 1 ex., 16. X. 1998, *on wing,* Ram Singh Coll.; MHARASHTRA: 5 exs., 24. IX. 1903, *on rice*, Surat, Bombay, without Coll.; PUNJAB: 4 ex., 22. VIII. 1997, *at light,* Ludhiana, Z. H. Khan Coll.; TAMIL NADU : 1 ex., 9. XI. 1915. *On paddy,* Madras; 15 exs., 18. IX. 1998, *at light,* Madurai; 4 exs., 22. IX. 1998, *at light,* Aduthurai; Several exs., 26, 27. X. 1998 *at light,* all Hydrabad, all Z. H. Khan Coll.; **[NPC]**

Distribution: Afghanistan, Australia, Bangladesh, Bhutan, Brunei, China, Throughout India, Indonesia, Japan, Kampuchea, Korea, Laos, Madagascar, Malaysia, Mynmar, Nepal, Pakistan, Papua- New guinea, Perssia Philippines, Sri Lanka, Taiwan, Thailand, Vietnam

Cnaphalocrocis poeyalis (Boisduval)

Boisduval 1833, *Faun. Ent. Madag.*, p. 33

Botys poeyalis Boisduval 1833, *Faun. Ent. Madag.*, p. 33

Cnaphalocrocis poeyalis (Boisduval); Shaffer *et al.,* 1996, *Check list of Lepidopetra of Australia, Pyralidae*, **4**: 199

Aspopia venilialis Walker 1859[a]. *List Spec. Ins. Coll. Brit. Mus.*, **17** : 373. (Synonymised by Shaffer *et.al.,* 1996)

Botys marisalis Walker 1859[b], *List. Spec. Lep. Ins. Coll. Brit. Mus.* , **18** : 717 (Synonymised by Shaffer *et.al.*, 1996)

Botys cicatricosa Lederer 1863, *Z. Wien. ent. Monat.,* **7** : 386 (Synonymised by Shaffer *et al.*, 1996)

Marasmia rectistrigosa Snellen 1872, *Tijdschr. Ent.,* **15** : 15 (Synonymised by Shaffer *et al.,* 1996)

Botys minutalis Mabille 1880, *C.R. Soc. Ent. Belg.*, **23**: 25 (Synonymised by Shaffer *et al.*, 1996)

Marasmia hampsoni Rothschild 1921, *Novit. Zool.*, **28** : 227 (Synonymised by Shaffer *et al.*, 1996)

Diagnostic characters: Head pale ochreous. Labial palpi ochreous and white beneath. Antennae whitish ocherous. Thorax light ochreous and paler posteriorly. Legs whitish; hind tibiae with outer spurs longer, twice than inner spurs. Abdomen pale ochreous; apex darker; base whitish. Fore wing moderate, triangular; costa straight with about 8 small dark spots, moderately arched towards apex; a curved antemedial dark line; a postmedial nearly straight line from costa to cubitus; a small black discocellular spot; cilia white at tips with brown line through it. Hind wing with two brown lines ending at anal angle and a marginal brown band; cilia whitish with brown inner line (Plate 8, figs. 107, 108, 109, Plate 19, fig. 238; Plate 23, figs. 281, 282).

Neuration

Fore wing: Sc reaching costal margin at more than half of the length of wing; R_1 from cell at about two-thirds of its length; R_2 and R_{3+4} from upper angle of cell, arising separately but just approximating after base to half of distance of R_{3+4}, then diverging and reaching costal margin at more than fifth-seventh length of wing; R_3 separated from R_4 at two-thirds of its length; R_4 reaching apex; R_5 close to R_{3+4} at base, diverging distally; M_1 separated from R_5 and quite apart from M_2; M_2 ,M_3 and Cu_1 close, equidistant basally and diverging distally; Cu_2 from cell at three-fourths distance of its length and running about parallel to Cu_1; 2nd A reaching margin; 3rd A from base, curved upwards and joining 2nd A (Plate 4, fig. 45).

Hind wing: $Sc+R_1$ reaching costal margin at more than four-fifths length of wing; Rs just after its origin, strongly anastomose with $Sc+R_1$ up to five-sixths distance of wing, then separated and reaching apex; M_1 from upper angle of cell; M_2, M_3 and Cu_1 close and equidistant basally, diverging distally; Cu_2 from cell at two-thirds distance of its length; 1st A, 2nd A and 3rd A complete (Plate 4, fig. 46).

Genitalia

***Male*:** Uncus reduced, bilobed and densely setose. Gnathos weakly sclerotized. Valva long, narrow and more or less rectangular; costal margin differentiated basally; sacculus conspicuous; apical margin deeply incurved with well defined lobes. Vinculum reduced. Saccus small and semimembranous. Aedeagus short and stout; cornutus present and composed of a sclerotized process bearing a row of seven long spines and another bearing five short spines (Plate 13, figs. 177, 178).

***Female*:** Papillae anales well developed and densely setose. Anterior apophyses longer than posterior apophyses. Ductus bursae short with sclerotized basal portion. Corpus bursae long and membranous; signum present on one side of corpus bursae towards the proximal end (Plate 17, fig. 213).

Length: 7-9mm

Wing span: 16-20 mm

Material examined: S. ANDAMANS: 2 exs., 1-10. VII. 1927, 2 exs., VIII. 1927, 2 exs., 15-27. VII. 1927, at light; all Ferrar Coll; 1 ex., 18. III. 1925, on Mitha Khari, Port Blair, Mujtaba Coll; BIHAR: 1 ex., 27. X. 1917, rolling leaves of Guenee grass, Haq. Coll.; 3 exs.,-. VIII. 1909, *Panicum* sp., A.M. Coll.; 2 exs., 22, 24. IX. 1914, 2 exs., 19. XII. 1914, 2 exs., 19, 24. XI. 1914; all Boy Coll.; 2 exs., 30. VII. 1923, 1 ex., 30. VII. 1936 Coll Bansi (H.) leaf folder, Rangi Coll.; (all from Pusa). 1 ex., -. IX. 1907, Ranchi, A.M. Coll .; WEST BENGAL: 1 ex., 12. XI. 1924, at light Calcutta S. Mukherji Coll.; 1 ex.,-. IX. 1907, Purulia, A.M. Coll. . **[NPC]**

Distribution: West and South Africa, Australia, Throughout India, Indonesia, Fiji, Mynmar, Solomon Island, Sri Lanka

Cnaphalocrocis suspicalis (Walker)

Walker 1859^b, *List spec. Lep. Ins. Coll. Brit. Mus.*, **18** : 667

Botys suspicalis Walker 1859 ^{b}, *List Spec. Lep. Ins. Coll. Brit. Mus.* , **18** : 667

Marasmia suspicalis (Walker); Bradley 1981, *Bull. ent. Res.* , **71** : 327

Cnaphalocrocis suspicalis (Walker) Shaffer *et al.,* 1996, *Check-list of Lepidoptera of Australia, Pyralid*, **4** : 199.

Botys convectalis Walker 1865, *List Spec. Lep. Ins. Coll. Brit. Mus.*, **34**: 1411. (Synonymised by Hampson 1896)

Cnaphalocrocis bifurcalis Snellen 1880[a], *Tijdsch. v. Ent.*, **23**: 219. (Synonymised by Hampson 1986)

Marasmia trapezalis; auctt. (*c.f.* Shaffer *et al.* 1996)

Diagnostic characters: Body ochreous, suffused with fuscous brown. Labial palpi blackish, white below. Fore wing ochreous; costal and outer areas suffused with brown; antemedial band incurved, extended from radio-median stalk to anal margin, first excurved and then recurved; postmedial band extended from costal margin to cubital vein and then excurved; two dark specks on discocellular. Hind wing with antemedial and medial oblique bands meeting at anal angle; postmedial band extended from $Sc+R_1$ to cubitus; outer area snffused with brown. Both wings with dark marginal line. Cilia pale (Plate 8, figs. 110, 111, 112; Plate 19, fig. 239; Plate 23, figs. 283, 284).

Neuration

Fore wing: Sc reaching costal margin at more than half of the length of wing; R_1 from cell at fifth-sixths of its length and reaching costal margin at three-fourths length of wing; R_2 closely approximated to R_{3+4}; R_{3+4} stalked and arising from upper angle of cell; R_3 separated from R_4 at three-fourths of its length; R_5 separate and basally close to R_{2+3+4} but diverging distally; M_1 very close to R_5 than M_2 basally; M_2 M_3 close basally and diverging distally; Cu_1 distant from M_3; Cu_2 from cell at two-thirds of its length; 2[nd] A reaching margin; 3[rd] A present basally and curved upwards towards 2[nd]A at one-third length of wing (Plate 4, fig. 47).

Hind wing: $Sc+R_1$ anastomosing with Rs for most of its length and separate near tip of wing; M_1 from upper angle of cell; M_2, M_3 very close basally and diverging distally; Cu_1 distant from M_3; Cu_2 from cell at two-thirds of its length, 1[st] A and 2[nd] A complete but 3[rd] A feeble (Plate 4, figs. 148).

Genitalia

Male: Uncus short and flat with two elongate, oval structures, covered with short hairs. Gnathos weakly sclerotized. Valva long and ovate covered with long hairs in patches; costal margin gradually convex; sacculus bearing a stout spine at the base. Vinculum with the saccus very long. Aedeagus long, stout and swollen at proximal end with two rod like sclerotized patches and a hook- like curved patch (Plate 13, figs. 179, 180).

Female: Papillae anales well developed and densely setose. Anterior apophyses longer than the posterior apophyses, both highly sclerotized. Ductus bursae relatively very short, anterior half portion sclerotized. Corpus bursae elongated, long bottle guard shaped, slightly, constricted in middle, slightly swollen at anterior end and mid portion of both side; signum absent (Plate 17, fig. 214).

Length: 10-11mm

Wing span: 18-22mm

Material examined: MEGHALAYA: 1 ex., -. XI. 1924, Shillong, Fletcher Coll.; 1 ex., -. IV. 1908, Guwahati, A. M. Coll.; BIHAR: 1 ex., Chapra, Mackenzie Coll.; no other data; 1 ex., 6. VII. 1926, 1 ex., 9. VIII. 1926, 1 ex., 11. IX. 1926, all at light, Pillai Coll.; 3 exs., 18.VIII. 1914, 1 ex., 13. VII. 1914, 20 exs., 16.VII. 1914; 5 exs., 17. VII. 1914, *all on maize*, P. Singh Coll.; 3 exs., 24. VIII. 1914, *on maize*, R.P.S. Coll.; 3 exs., 6, 6, 4. VII. 1914, *on maize*, A. H. Coll.; 1 ex., 21. IX. 1914, 2 exs., 9, 19. XII. 1914, 2 exs., 29, 30 . IV. 1914, all Boy Coll.; 1 ex., 27. VII. 1913, on maize, C.B. S. Coll.; 1 ex, 5. X. 1906, *on grass*, R. B. Misra Coll.; 1 ex., 2. VII. 1906, *on maize*, 1 exs., 17 .X. 1905, *on Jawar*, no Coll.; 1 ex., 2. VII. 1905, *on Brinjal*, R. B. Mishra Coll.; 1 ex., 12. VI. 1916, *on Sweet Potato*, H. P. Singh, Coll.; 1 ex., 9. VII. 1916, *on grass*, H.P. Singh Coll.; 3 exs., 22. VII. 1916, D. Nandan Coll.; 1 ex., 22. VII. 1916, Ghosh Coll.; 1 ex., 27. VIII. 1921, *on Sugarcane*, Rangi Coll.; 3 exs., 7, 15, 28. VII. 1915, *at light*, U. Bahadur Coll.; 1 ex., 9. XI. 1926, *at light*, Pillai Coll.; 1 ex., 6. IX. 1926, Mukherjee Coll.; (all from Pusa)]; DELHI: 1 ex., 2. IX. 1938, *on Jwar*, B.B. Bose Coll.; 1 ex., 1. VII. 1938, *Jwar*, F.L.C. Coll.; 1 ex., 2. IX. 1938. Mahi Coll.; 2 exs., 3,5,. VII. 1938, *Jwar*, F.L.C. Coll.; 1 ex., 2 . IX. 1938, Mahi Coll; 2 exs., 3, 5. VII. 1938. Chaudhari Coll; 1 ex., 18. IX. 1959, *all on Iwar*; G.K.V. Ganda Coll.; MAHAHRASHTRA: 1 ex., 17. VIII. 1901, *on Iwar*, Nagpur; NICOBAR: 1 ex., 22-

26. III. 1925, Mujtaba Coll.; TAMIL NADU: 1 ex., 15. VII. 1917, *on cane*, Coimbatore, Fletcher Coll.; SIKKIM: 1 ex., 18-30. IV. 1922, Sikkim, Fletcher Coll.; **[NPC]**

Distribution: Oriental and Australian Region.

Cnaphalocrocis bilinealis (Hampson)

Hampson 1981, *Ill. Typ.Spec. Lep. Hel. Brit. Mus.*, **8** : 139

Dolichosticha biliniealis Hampson 1891, *Ill. Typ. Spec. Lep. Het. Brit. Mus.*, **8** : 139.

Marasima bilinealis (Hampson); Hampson 1896, *Faun. Brit. Ind. Moths*, **4** (1); 277

Cnaphalocrocis bilinealis (Hampson); Shaffer *et al.*, 1996, *Check-list of Lepidoptera of Australia,Pyralidae,* **4** : 199

This species could not be studied because of non availability of material.The name *Dolichosticha bilinealis* was given as manuscript name by Warren but actually described by Hampson (1891).

Wing span: 20-21 mm

Distributions: Celebes, China, India (Assam, , Kerala, Tamil Nadu), Indonesia, Malakka, Sri Lanka

Cnaphalocrocis patnalis (Bradley)

Bradley 1981, *Bull. ent. Res.,* **71**: 323

Marasmia patnalis Bradley 1981, *Bull.ent. Res.*, **71** : 323

Cnapholocrouis patnalis (Bradley); Comb. nov.

This species could not be examined because of non-avaialability of specimens. This species is hereby transferrred from genus *Marasmia* Lederer to *Cnaphalocrocis* Lederer because former genus is junior synonym of latter (Plate 23, fig.280).

Wing span: 15-18 mm

Distribution: India (Andhra Pradesh, Orissa, Tamil Nadu), Indonasia, Malaysia, Philippines, Sri Lanka

Remarks: This species was originally described under genus *Marasmia* Lederer but as a result of the synonymy of this genus with that of *Cnaphalocrocis* Lederer, the species *patnalis* has been transferred and proposed as new combination.

Crypsiptya Meyrick

Meyrick 1894[b], *Trans. ent. Soc. Lond.*, p. 463

Coclebotys Munroe and Mutuura 1969, *Canad. Ent.*, **100** (8): 862 (Synonymised by Shaffer *et al.*, 1996)

(Type species: *Crypsiptya nereidalis* (Lederer))

Diagnostic characters: Labial palpi porrect, triangularly scaled; 3rd joint hidden by hairs. Maxillary palpi filiform. Hind legs with outer tibial spurs smaller than inner spurs. Thorax of male with large lateral extensible plate of greatly elongated sclaes below. Fore wing with veins Cu_1 , M_3 and M_2 from close to lower angle of cell; R_{3+4} stalked; R_2 free or rarely, anastomosing with R_{3+4}. Hind wing with veins M_2 and M_3 not approximated towards their origin; M_1 and R_s from upper angle of cell; vein Rs anastomosing with $Sc+R_1$ just after its origin.

This genus has a single species *i.e., Crypsiptya coclesalis* (Walker) from India, which is reported as a pest of rice and included in the present study.

Crypsiptya coclesalis (Walker)

Walker 1859[b], *List Spe. Lep. Ins. Coll. Brit. Mus.* **18** : 701

Botys coclesalis Walker 1859[b], *List. Spec. Lep. Ins. Coll. Brit. Mus.*, **18** : 701

Hapalis coclesalis (Walker); Swinhoe 1890. *Trans. ent. Soc.* Lond., p. 269

Pyrausta coclesalis (Walker); Hampson 1896, *Faun. Brit. Ind. Moths*, **4** (2); 441

Nascia coclesalis (Walker); Swinhoe 1900, *Cat. Lep. Het. Oxford Mus.*, **2** : 534

Crypsiptya coclesalis (Walker), Shaffer *et al.*, 1996, *Check list of Lepidopetra of Australia, Pyralidae*, **4** : 189.

Botys itemalesalis Walker 1859[c], *List Spec. Lep. Ins. Coll. Brit. Mus.*, **19**: 996. (Synonymised by Hampson 1896)

Botys strenualis Walker 1865, *List Spec. Lep. Ins. Coll. Brit. Mus.*, **34**: 1409 (Synonymised by Hampson 1896)

Botys interfusalis Walker 1865, *List Spec. Lep. Ins. Coll.Brit. Mus.*, **34**: 1443 (Synonymised by Hampson 1896)

Botys lacrymalis Leech 1889, *Entom.*, **22**: 69 (Synonymised by Shibuya 1928-29)

Diagnostic characters: General colour ochreous brown. Body moderately stout with white ventrally. Labial palpi ventrally white; 2nd joint about 3x as longer as than 3rd, 3rd joint conical. Antennae slender. Legs smooth, slender. Fore wing with the veins, costal area and outer area darker; antemedial line obliquely waved; postmedial line highly excurved from vein M_2 to Cu_2; discocellular with a purplish reniform spot. Hind wing pale; outer area dark; postmedial line highly excurved (Plate 8, figs. 113, 114, 115; Plate 19, fig. 240; Plate 24, figs. 285, 286)

Neuration

Fore wing : Sc reaching costal margin at more than three-fifths length of wings; R_1 from cell at more than three-fourths distance of its length, reaching costal margin at three-fourths length of wing; R_2 separate, originating from upper angle of cell and running very close to R_{3+4} towards margin; R_{3+4} stalked; R_3 separated from R_4 at about two-fifths distance of its length and very slightly diverging distally; R_5 well separated from R_{3+4} and M_1 basally , about equidistant, diverging distally. M_1 and M_2 quite apart; M_2 and M_3 close basally, diverging distally; Cu_1 distant from M_3; Cu_2

from cell at three-fourths distacne of its length; 2nd A complete and reaching to margin (Plate 4, fig. 49).

Hind wing: $Sc+R_1$ reaching costal margin near to apex of wing; Rs just after its origin, anastomose with $Sc+R_1$, up to two-thirds of wing, then separate and reaching apex; M_1 from upper angle of cell; M_2 and M_3 close basally, diverging distally; Cu_1 distant from M_3; Cu_2 from cell at less than two-thirds of its length; 1st A, 2nd A and 3rd A complete (Plate 4, fig. 50).

Genitalia

Male: Uncus of moderate size, broad, sclerotized, tip pointed, slightly hook-like and heavily setose. Gnathos slightly shorter than uncus. Valva long, broad, setose, apex rounded; three hook-like spines present on both valvae; costal margin sclerotized; sacculus large, broad, setose. Vinculum conical. Saccus U-shaped and short. Aedeagus slender, sclerotized ; cornuti present in form of small pins (Plate 13, figs. 181, 182).

Female: Papillae anales long, broad and densely setose, Posterior apophyses shorter than anterio. Ductus bursae long, constricted and sclerotized. Corpus bursae globular; signum prominent, bilobed, triangular, heavily sclerotized and situated in the middle of the corpus bursae (Plate 17, fig. 215).

Length: 9-18 mm

Wing span: 21-30 mm

Material examined: BIHAR: 1 ex., 29. VII. 1922, 2 exs., 4, 21. VIII. 1922, larvae rolling bamboo leaves, Rangi Coll.; 1 ex., 20 VIII. 1915, Boy Coll.; 1 ex., 14. VII. 1905, on sugarcane, C. S. M. Coll.; (all from pusa); MAHARASHTRA: 2 exs., 4. VIII. 1903, rolling bamboo leaves, R.R. K. Coll.; 2 exs., 30. VII. 1903, rolling bamboo leaves, 1 ex., 10. VIII. 1908; 2 exs., 13 VIII. 1908, 2 exs., 15. VII. 1908; 2 exs., 16 VIII. 1908 all without other data; 1 ex., 4. VIII. 1913, rolling bamboo leaves, R. R. K. Coll.; 2 exs., O. Lindgren Coll.; no other data; 1 ex., 17. VIII. 1941, rolling bamboo leaves, T.R. Santokay Coll.; 1 ex., 15. VIII. 1908, without other data (all from Nagpur); NICOBAR: 2 exs., 22-26. III. 1925, Mujtaba Coll. **[NPC]**

Distribution: Australia, China, Throughout India, Indonesia, Japan, Myanmar, Sumbawa, Taiwan

Remarks: Placement of this species in *Crypsiptya* Meyrick is doubtful because of the hind tibiae with outer tibial spurs in male being very minute which is character of genus *Nascia* Curtis. However, because of the presence of a fan of scales on ventral side of thorax near base of fore wing of male, this species is near to *Crypsiptya* Meyrick. Unless and until types of both the genera are seen, it is rather difficult to accomplish its identity and hence for the present this species is retained in *Crypsiptya* Meyrick

Herpetogramma Lederer

Lederer 1863, *Z. Wien. ent. Monat.*, **7** : 430

Herpetogramma Lederer 1863, *Z. Wien. ent. Monat.*, **7** : 430

Pachyzancla Meyrick 1884, *Trans. ent. Soc.* Lond., : p. 315. (Synonymised by Amsel 1954)

Acharana Moore 1884-87 , *Lep. Ceylon* , **3**: 285 (Synonymised by Amsel 1954)

Piloptila Swinhoe 1894, *Ann. Mag. nat. Hist.*, (s.6) **14**: 142 (Synonymised by Amsel 1954)

Pantoecome Warren 1896[b], *Ann. Mag. nat. Hist.,* (s.6) **18**: 173 (Synonymised by Shaffer *et.al.* 1996)

Ṗtiloptila Hampson 1899, *Proc. zool. Soc.* Lond., p. 291 (Misspelling)

Macrobotys Munroe 1950, Canad. Ent., **82**(11): 228. (Synonymised by Shaffer *et al.*, 1996) (cf. Shaffer *et al.*,1996)

(Type specices : *Botys licarsisalis* Walker)

Diagnostic characters: Labial palpi porrect; 2[nd] joint densely rough scaled; 3[rd] joint hidden by hairs. Maxillary palpi short, filiform. Antennae short. Hind legs with outer tibial spurs half of the length of inner spurs. Fore wing with veins Cu_1, M_3 and M_2 from near lower angle of cell; R_2 approximated to R_{3+4}; R_1 moderately long and oblique. Hind wing as broad as fore wing; M_2 and M_3 approximated basally for a short distance; Rs after its origin, anastomose with $Sc+R_1$ beyond one-thirds of its length; discocellular cell short.

This genus has 9 species from India, of which two species are reported as pest of rice. These can be recognized by the following key:-

Key to the species of *Herpetogramma*

1. Fore wing of male with basal half of costa fringed below with long thick black hairs ------------------------------ *H. licarsisalis* (Walker)
- Fore wing of male without such hairs------------------------*H. phoeopteralis* (Guenee)

Herpetogramma licarsisalis (Walker)

Walker 1859[b], *List. Spec. Lep. Ins. Coll. Brit. Mus.*, **18** : 686.

Botys licarsisalis Walker 1859[b], *List. Spec. Lep. Ins. Coll. Brit. Mus.* , **18**: 686

Pharacia licarsisalis (Walker); Hampson 1893, III. *Typ. Spec. Lep. Het. Brit. Mus.*, **9** : 46

Pachyzancla licarsisalis (Walker); Hampson 1899, *Proc. zool. Soc.* Lond., p. 202

Acharana licarsisalis (Walker); Swinhoe 1900, *Cat. Lep. Het. Oxford Mus.*, **2** : 526

Psara licarsisalis (Walker); Shibuya 1928-29, *J. Fac. Agr. Hokkaido Imp. Univ. Sapporo*, **22**: 263

Herpetogramma licarsisalis (Walker); Rose and Pajni 1985; *Res. Bull. Punjab Univ.*, **36** (3-4) : 210

Botys phraxalis Walker 1859[b], *List. Spec. Lep. Ins. Coll. Brit. Mus.*, **18** : 725 (Synonymised by Hampson 1896)

Entephria fumidalis Walker 1865, *List. Spec. Lep. Ins. Coll. Brit. Mus.*, **34**: 1486 (Synonymised by Hampson 1899)

Botys immundalis Walker 1865, *List. Spec. Lep. Ins. Coll. Brit. Mus.*, **34**: 1448 (Synonymised by Shaffer *et al.*, 1996)

Psara serotinalis Joannis 1888, *Ann. Soc. ent. Fr.*, **25**: 272 (Synonymised by Hampson 1899)

Diagnostic characters: General colour fuscous. Labial palpi white beneath. Fore legs clothed with rough hairs near the femoro-tibial joint. Fore wing of male fringed with long, thick, black hairs on ventral side of basal half of costa; an oblique antemedial line; a speck in the cell and a discocellur oblique patch; a dark postmedial outwardly bent line. Hind wing with an antemedial faint line; a discocellur dark patch; a postmedial indistinct outwardly bent line. Both wings with fulvous marginal line (Plate 9, figs. 116, 117, 118; Plate 19, fig. 241; Plate 24, figs. 287, 288, 289).

Neuration

***Fore wing*:** Sc reaching costal margin at about two-thirds length of wing; R_1 from cell at three-fourths distance of its length, reaching costal margin at more than two-thirds length of wing; R_2 closely approximated to R_{3+4} and diverging from one-fourth distance of its length; R_{3+4} stalked; R_5 separate but very close to R_{3+4} and diverging distally from one-fourths distance from end of cell to apex; M_1 well separated from R_5 and for a short distance running parallel to it; M_2 and M_3 from lower angle of cell, very close basally, diverging distally; Cu_1 also close to M_3 basally but not like M_2, diverging distally; Cu_2 from cell at three-fourths distance of its length; 2nd A complete and reaching margin; 3rd A after some distance turned upwards and join with 2nd A before mid point of its length (Plate 4, fig. 251).

Hind wing: $Sc+R_1$ reaching costal margin at near to apex of wing; Rs just after its origin, anastomose with $Sc+R_1$ upto two-thirds of the length of wing, then separated and reaching apex; M_1 from upper angle of cell connected to $Sc+R_1$ and Rs by a short vein, running weakly towards base of wing; M_3 approximated and much closer to M_2 than Cu_1. Cu_2 from cell at two-thirds distance of its length, running parallel to Cu_1 towards margin; 1st A, 2nd A and 3rdA complete but 3rd A weak (Plate 4, fig. 252).

Genitalia

Male: Uncus tapering towards apex, heavily setose. Gnathos rod-like and shorter than uncus. Valva long and smooth; costal margin heavily sclerotized; sacculus heavily sclerotized and tubular; clasper hook-like. Vinculum subquadrangular with the saccus moderately developed. Aedeagus small, thickly sclerotized with a sclerotized band near base to apex almost covered with small spines (Plate 13, figs. 183, 184).

Female: Papillae anales narrow and setose. Anterior apophyses longer than posterior. Ductus bursae long and sclerotized. Corpus bursae sac-like , membranous; signum arranged horizontally at the centre of corpus bursae (Plate 17, fig. 216).

Length: 8-14 mm

Wing span: 16-26 mm

Material examined: BIHAR : 4 exs., 24. IV. 1915, 2 exs., 27, 29. IV. 1915, 2 exs., 30. IV. 1915, 3 exs., 5,18,19.V.1915, 5 exs., 1. VII. 1915, 2 exs., 4. VII. 1915, 1ex., 30. VII.1915, 2 exs., 20. VIII.1915, 3 exs., 6, 12, 27. VIII. 1915, 2 exs., 16. IX.1915, 2 exs.. 13. IX. 1915, 2 exs., 4, 15. IX. 1915, 2 exs., 30, 15. VI. 1915, 1ex., -III. 1916, all Boy Coll.; 1ex., 24.X.1916, on Cowpea, H.Singh Coll.; 2 exs., 22. IX. 1924, Haq.Coll.; 3 exs., 21. X. 927, Fletcher Coll.; 1ex., 22 . VI. 1906, A.M. Coll.; 1ex., 26. VIII. 1910, T.B.F. Coll.; 1ex., 9.X.1925 R. Sharma Coll.; 2 exs., 29.IX.1925, on Varanda of College, Sharma Coll.; [Pusa]; 1ex., -. IX. 1907, Ranchi, A.M. Coll. MAHARASHTRA: 1ex., -. IX. 1899, A.M. Coll.; WEST BENGAL: 8 exs., no other data. Kalimpong, Lindgren Coll.; 1ex., 18-30.IV.1922, 1ex., -. V. 1922, 3 exs., 7-20. VI. 1922, all Kurseong, 1ex., 18-30. IV. 1922, Kalimpong, Fletcher Coll. S. ANDAMAN: 1ex., 26. VIII, 1927, 2 exs., 1, 30. VII. 1927, 3 exs., 20. VII. 1927, 1ex., 1-10. VII. 1927, 1ex., 15-27. VII. 1927, all Ferrar Coll.; MEGHALAYA: 1 ex., -. X. 1916. Cherapunji, Native Coll.; 3 exs., 27. IX. 1924, 3 exs., 28. X. 1924, (all from Shilong), Fletcher Coll. **[NPC]**

Distribution: Australia, China, Fiji, Hong Kong, Throughout India, Indonesia, Japan, Malacca, Marshall Island, Philippines, Sri Lanka, Taiwan

Herpetogramma phoeopteralis (Guenee)

Guenee 1854, *Delt. et. Pyral.*, **8**: 349

Botys phoeopteralis Guenee 1854, *Delt. et Pyral*, **8**: 349

Pachyzancla phoepteralis (Guenee); Hampson 1896, *Faun. Brit. Ind. Moths*, **4** (2): 402

Psara phoeopteralis (Guenee); ; Klima 1936, *Lep. Cat.* , **89** : 224

Herpetrogramma phoeopteralis (Guenee); Amsel 1954, *Bol. Ent. Venezol.*, **10**: 178

Botys otreusalis Walker 1859[b], *List Spec.Lep. Ins. Coll.Brit.Mus.*, **18**: 637 (Synonymised by Moore 1884-87)

Botys triarialis Walker 1859[b], *List Spec. Lep. Ins. Coll. Brit. Mus.*, **18**: 639 (Synonymised by Moore 1884-87)

Botys vestalis Walker 1859[b], *List Spec. Lep. Ins. Coll.Brit. Mus.*, **18**: 579 (Synonymised by Hampson 1896).

Botys abstrusalis Walker 1859[b], *List Spec Lep. Ins. Coll. Brit. Mus.*, **18** : 663 (Synonymised by Hampson 1896)

Diagnostic characters: General colour fuscous, slightly darker and purplish than *H. licarsisalis* (Walker). Fore legs normal. Fore wing of male without fringe of black hairs on ventral side of costa; basal area fuscous; marginal area dark; maculation same as in *H. licarsisalis* (Walker) with discocellular spot slightly bigger and darker. Hind wing with maculation of same type as in fore wing. Femoro-tibial joint without rough hairs (Plate 9, figs. 119, 120, 121; Plate 19, fig. 242; Plate 24, figs. 290, 291).

Neuration

***Fore wing*:** Sc reaching costal margin at less than two-thirds length of wing; R_1 from cell at more than three-fourths distance of its length and reaching costal margin at more than two-thirds length of wing; R_2 very closely approximated to R_{3+4} from upper angle of cell to less than half of the length of stalk of R_{3+4}; R_{3+4} stalked; R_3 separated from R_4 at about three-fifths distance of its length; R_4 to apex; R_5 separate but closely approximated to R_{3+4} and diverging distally at about one-fifths distance of its length; M_1 also close to R_5 basally, diverging distally; M_2 quite apart from M_1 and running about parallel to each other; M_3 equidistant from M_2 and Cu_1 basally; Cu_2 from cell at three-fourths distance of its length; 2nd A reaching to margin; 3rd A very short, turned upwards and join 2nd A before mid points of its length (Plate 4, fig. 53).

***Hind wing*:** $Sc+R_1$ reaching to costal margin at very near to apex of wing; Rs just after its origin, anastomose with $Sc+R_1$ up to four-sevenths of its length, then separate and reaching apex of wing; M_1 from upper angle of cell; M_2 and M_3 approximated and very close basally, diverging distally; Cu_1 distant to M_3; Cu_2 from cell at more than half of the distance of its length and about parallel towards inner margin; 1st A, 2nd A and 3rd A complete (Plate 4, fig. 54).

Genitalia

***Male*:** Uncus acuminate, heavily setose. Gnathos membranous and longer than uncus. Valva large, broad, setose; costal margin heavily sclerotized, setose from base to two-fifths of its length; sacculus tubular, heavily sclerotized. Vinculum narrow with the saccus moderately developed. Aedeagus rod-shaped; cornutus pin-shaped (Plate 13, figs. 185, 186).

***Female*:** Papillae anales small, narrow and densely setose. Anterior apophyses longer than posterior. Ductus bursae short and longitudinally folded. Corpus bursae membranous and baloon-shaped; signum present and horizontally arranged near the apex (Plate 17, fig. 217).

Length: 10-13 mm

Wing span: 22-26 mm

Material examined: ANDHRA PRADESH: 1 ex., 6.IX. 1913, Dharwar, no Coll.; ASAM: 1 ex., -. IV. 1908, A. M. Coll.; BIHAR: 3 exs., 19. XI. 1914, 2 exs., 26, 7. XI. 1914, 5 exs., 25. X. 1914, 2 exs., 12, 21. X. 1914, 2 exs., 22. XII. 1914, 2 exs., 23. XII. 1914, 3 exs., 16. X. 1914, 4 exs., 5, 9, 12, 27. XII. 1914, all Boy Coll.; 1 ex., 10. X. 1910, 1 ex., 4. I. 1911 all T.B.F. Coll.; 1 ex., -. XII. 1908, R. D. D. Coll.; 1 ex., 16. XII. 1931, 1 ex., 26. X. 1932, all Bose Coll.; 1 ex., 5. XI. 1915, U. Bahadur Coll.; 1 ex., 2. XII. 1926, 1 ex., 24.VIII. 1924, all G.P. Pillai Coll.; 2 exs., 6. XI. 1920, Fletcher Coll.; 1 ex., 26. IX. 1908 , R. B. D. Coll.; (all from Pusa); KARNATAKA: 1 ex., 19. X. 1917 Bangalore, T. R. N. Coll.; MAHARSHTRA: 1 ex., 24. I. 1928, Bombay, Fletcher Coll.; MEGHALAYA: 1 ex., -. VIII- X. 1919, Khasi hill, Shillong, 1 ex., 15. IX. 1919, Shillong, all Fletcher Coll.; ORISSA: 1 ex., -. X. 1906, Cuttackk, A. M. Coll.; SIKKIM: 3 exs., -. III-VII. 1932, Kalimpong, , Lindgeren Coll.; S. ANDAMAN: 5 exs., -. V-VI. 1927, *at light,* Ferrar Coll.; 2 exs., 18-28. II. 1925, Port Blair, Shaffi Coll.; 2 exs., 19. II. 1925, Port Blair, Mujtaba Coll.; TAMIL NADU: 2 exs., 27. XI. 1923, Coimbatore, M. C. C. Coll.; 5 exs., -. X. 1921, Kodai Kanal, Fletcher Coll.; WEST BENGAL: 1 ex., -. IV. 1908, Bagerhat, 1 ex., -. IX. 1906 Palamow, 4 exs., -. X. 1906, Balasor, 1 ex., -. X. 1906, Badrakh, 1 ex., 1. X. 1906, Bengal, all A.M. Coll; 1 ex., 7. XI. 1924, *at light,* Calcutta, S. Mukerji Coll. **[NPC]**

Distribution: Ethiopia, Throughout India, Myanmar, Neotropical Region, Solomon Island, Sri Lanka

Mabra Moore

Moore 1884-87, *Lep. Ceylon,* **3** : 280

Streptobela Turner 1937, *Proc. R.. Soc. Qd.,* **48** : 61 (Synonymised by Shaffer *et al.,* 1996)

(Type species : *Asopia eryxalis* Walker)

Diagnostic characters: Labial palpi porrect, triangularly scaled; 3rd joint lanceolate and half of the length of 2nd joint. Maxillary palpi ascending. Frons rounded. Legs smooth, short, tibial spurs of hind legs long and equal. Fore wing elongate, triangular; outer margin oblique, slightly convex in the middle; veins Cu_1, M_3 and M_2 from lower angle of cell; R_5 well separated from R_{2+3+4}; discocellular cell half of the length of wing. Hind wing rather narrow; veins Cu_1, M_3 and M_2 from lower angle of cell; Rs strongly anastomose with $Sc+R_1$.

This genus has 5 species from India, *M. eryxalis* (Walker) is reported as a pest of rice.

Mabra eryxalis (Walker)

Walker 1859[a], *List Spec. Lep. Ins. Coll. Brit. Mus.*, **17** : 371

Asopia eryxalis Walker 1859[a], *List spec. Lep. Ins. Coll. Brit. Mus.*, **17** : 371

Mabra eryxalis (Walker); Moore 1884-87, *Lep. Ceylon*, **3** : 281

Botys velatalis Snellen 1880[b], *Veth. Meded.- Sumat.*, 4 (Lep.) : 63 (Synonymised by Shibuya 1928-29).

Diagnostic characters: Body colour ochreous yellow. Antennae of male with long cilia. Fore legs cinereous-brown; hind legs whitish. Abdomen brownish, speckled with slender white-segmented bands. Fore wing with an indistinct sinuous orange antemedial line; discal area suffused with fuscous, discocellular lunule black; postmedial line sinuous dark, outwardly oblique to vein Cu_1, then recurved to angle of cell and excurved again; submarginal line orange, indistinct and waved. Hind wing suffused with fuscous; marginal area orange; submarginal line orange and waved (Plate 9, figs. 122, 123, 124; Plate 19, fig. 243; Plate 24, figs. 292, 293).

Neuration

Fore wing: Sc reaching costal margin at about half of the length of wing; R_1 separate and from upper angle of cell and closely running to R_{2+3+4}, diverging from one-thirds of its length and reaching costal margin at about three-fourths length of wing; R_{2+3+4} stalked; R_2 from R_{3+4} at more than half of the distance of its length; R_3 from R_4 at more than two-thirds distance of its length; R_4 to apex; R_5 well separated from R_{2+3+4} but close to M_1 basally, diverging distally; M_2, M_3 and Cu_1 close basally, diverging distally; Cu_2 from cell at about two-thirds distacne of its length; 2nd A reaching margin (Plate 5, fig. 55).

Hind wing: Sc+R_1 reaching costal margin at very near to apex of wing; Rs just after its origin anastomose with Sc+R_1 up to half of the length of wing, then separate and reaching to apex; M_1 from upper angle of cell, diverging distally; M_2, M_3 and Cu_1 close and equidistant basally, diverging distally; Cu_2 from cell at two-thirds distance of its length; 1st A, 2nd A and 3rd A complete (Plate 5, fig. 56).

Genitalia

Male: Uncus long sclerotized, gradually narrow towards apex; tip pointed like needle. Gnathos short. Vinculim short, rather broad, slightly sclerotized. Saccus less developed. Valva long, narrow, broad in middle, curved at apex, densely covered with hairs; a kidney-shaped semicircular sclerotized structure present in the middle towards costal margin. Aedeagus short, cylindrical with cornuti in the form of sclerotized structure (Plate 13, figs. 187, 188).

Female: Papillae anales relatively very small, densely setose. Anterior apophyses longer than posterior. Ductus bursae membranous Corpus bursae elongated, membranous; signum absent (Plate 17, fig. 218).

Length: 5-7 mm

Wing span: 12-15 mm

Material examined: S. ANDAMAN: 11 exs., VIII. 1927, Ferrar Coll.; 4 exs., 20. VII.- VIII. 1927, Ferrar Coll.; Port Blair.; 2 exs., 11. 13. III. 1925, on Mitha Khari, Mujtaba Coll.; 1 ex., . -. VIII – X. 1927, Ferrar Coll. BIHAR: 2ex., Chapra, Mackenzie Coll; [1 ex., 14. XII. 1934, H.P.S. Coll.; 3 exs., 1,6. X. 1915, at light, U. Bahadur Coll.; 1 ex., 6. X. 1915, T.B.F. Coll.; 3 exs., 29, 30. VIII. 1922, larvae rolling and feeding bamboo leaves, Rangi Coll.; 7 exs., 19. XI. 1934, *on paddy* Rangi Coll.; 3 exs.. 18. IX. 1934; 4 exs., 19. IX. 1934; 1 ex. 20. IX. 1934; 4 exs., 21. IX. 1934; 2 exs.. 22 . IX. 1934; 1ex. 23. IX. 1934; 7 exs., 24. IX. 1934; 1ex. 25. IX. 1934, *all on paddy*, Rangi Coll.; 2 ex., 18. IX. 1931, *on paddy* , Rangi Coll.; 1 ex., 21. IX. 1928, E. Hassan Coll.; 1 ex., 8. XI.- on leaf of *Eleusine* sp. Hay Coll.; 1 ex., -. IX. 1907, Ranchi, A.M. Coll. WEST BENGAL: 1 ex., -. IX. 1906, Palamow, A.M. Coll.; 1 ex., -. IX. 1907, Puralia, A. M. Coll.; 1 ex., Puralia, rolled leaf of *Raunea Aspunifolia*, Rangi Coll. **[NPC]**

Distribution: Australia, India (Andaman, Bihar, Nagaland, Punjab, Sikkim), Indonesia, Myanmar, Philippines, Singapore, Sri Lanka, Taiwan.

Notarcha Meyrick

Meyrick 1884, *Trans. ent. Soc. Lond.*, p. 310

Haritala Moore 1884-87, *Lep. Ceylon*, **3**: 311 (Replacement name)

(Type species: *Phalaena derogata* Fabricius)

Diagnostic characters: Labial palpi moderately arched, ascending; 2[nd] joint fringed with scales; 3[rd] joint very short and naked. Maxillary palpi filiform. Antennae of male filiform and ciliated. Hind tibiae with outer spurs one-thirds of inner spurs. Abdomen with slender anal tuft in male. Fore wing short and broad; veins Cu_1, M_3 and M_2 from lower angle of cell; R_5 well separated from R_{3+4} to which vein R_2 is closely approximated; vein R_1 long and oblique. Hind wing slightly broader than fore wing with the cell short; vein Cu_1, M_3 and M_2 from lower angle of cell and approximated at base; R_s originating near M_1 from upper angle of cell and anastomising with $Sc+R_1$; hind wing of male without tuft and vesicle on inner area.

This genus has two species from India, of which N. obrinusalis (Walker) is recorded as a pest of rice.

Notarcha obrinusalis (Walker)

Walker 1859[b], *List Spec. Lep. Ins. Coll. Brit. Mus.*, **18** : 549

Astura obrinusalis Walker 1859[b], *List Spec. Lep. Ins. Coll. Brit. Mus.*, **18** : 549

Pycnarmon obrinusalis (Walker); Moore 1877, *Proc. zool. Soc.* Lond., p. 617

Haritala obrinusalis (Walker); Cotes and Swinhoe 1887-89, *Cat. Moths India*, p. 637

Lygropia obrinusalis (Walker); Hampson 1896, *Faun. Brit. Ind. Moths*, **4** (2): 341

Notarcha obrinusalis (Walker); Shaffer *et al.*, 1996, *Check list of Lepidopetra of Australia, Pyralidae,* **4** : 197

Botys trigalis Lederer 1863, *Z. Wien ent. Monat.*, **7** : 375 (Synonymised by Hampson 1896)

Botys graphicalis Swinhoe 1886, *Proc. zool. Soc.* Lond., p. 459 (Synonymised by Hampson 1896)

Pionea nigripunctalis Fawcett 1916, *Proc. zool. Soc.* Lond., p. 736 (Synonymised by Shaffer *et al.*, 1996)

Diagnostic characters: General colour bright orange-yellow, Labial palpi with 3rd joint black. Fore tibiae black towards tip; fore tarsi with black bands. Fore wing with black costal dots in subbasal, antemedial and post medial regions; discal dot black; antemedial line orange , indistinct slightly bent outwards between veins R_1 and M_2, then retracting to lower angle of cell; postmedial line indistinct, curved and minutely waved. Hind wing with subbasal line orange; discocellular dot dark; postmedial line minutely dentate, bent outwards from veins R_1 to M_2 where it meets with the projected submarginal line which is also minutely dentate (Plate 9, figs. 125, 126, 127; Plate 19, fig. 244; Plate 25, figs. 294, 295).

Neuration

***Fore wing*:** Sc reaching costal margin at about three-fourths length of wing; R_1 from cell at three-fourths of its length and reaching costal margin near to Sc; R_2 approximated to R_{3+4} basally, diverging at one-fourths distance from end of cell to apex and reaching costal margin at four –fifths length of wing; R_{3+4} stalked; R_3 separated from R_4 at three-fifths distance from end of cell to apex of wing; R_5 well separated and close basally to M_1 than R_{3+4}, diverging distally; M_1 and M_2 quite apart and running about parallel; M_2, M_3 and Cu_1 close and equidistant basally, diverging distally; Cu_2 from cell at three-fourths of its length; 2nd A complete and reaching to margin; 3rd A short, joining 2nd A by an upward curve before half of its length (Plate 5, fig. 57).

***Hind wing*:** Sc+ R_1 reaching costal margin near to apex of wing; Rs just after its origin, anastomose with Sc+R_1 up to three-fifths of its length, then separate and reaching apex; M_1 from upper angle of cell; M_2 and M_3 and Cu_1 close and equidistant basally, diverging distally; Cu_2 from cell at about two-thirds of its length; 1st A, 2nd A and 3rd A complete (Plate 5, fig. 58).

Genitalia

***Male*:** Uncus short, conical, hairy. Gnathos shorter than uncus. Valva long, broder at apex, hairy; costal and saccular margin sclerotized. Vinculum narrow and dome-shaped. Saccus. U-shaped and short. Aedeagus rod-like sclerotized structure (Plate 14, figs. 189, 190).

***Female*:** Papillae anales short narrow and hairy. Posterior apophyses shorter than anterior. Ductus bursae short and sclerotized. Corpus bursae elongated, slightly constricted in middle, signum very prominent, bean-shaped situated near the base of corpus bursae (Plate 18, fig. 219).

Length: 7-10 mm

Wing span: 17-23 mm

Material examined: BIHAR: 4 exs., 8. VI. 1906, D.P.S. Coll.; 1 ex., 8. VI. 1906, *on grass*, D.P.S. Coll.; 1 ex., -. VI. 1909, C.W.M. Coll.; 2 exs., 1, 17. IV. 1915, Boy Coll.; 1 ex., 3. VI. 1908, C. W.M. Coll.; 1 ex., 29 .IV. 1914, Boy Coll.; 1 ex., 28. IX. 1914, Boy Coll.; (all from Pusa;], PUNJAB: 1 ex., 22. IV. 1941, U. Bahadur Coll. **[NPC]**

Distribution: India (Andaman, Himanchal Pradesh, Nicobar, Orissa, Punjab, TamilNadu), Indonesia

Pleuroptya Meyrick

Meyrick 1890, *Trans. ent. Soc. Lond.* : p. 443

Loxoscia Warrren 1890. *Ann. Mag. nat. Hist*., (s. 6) **6** : 476 (Synonymised by Shaffer *et al.,* 1996)

(Types sepcies: *Phalaena balteata* Fabricius)

Diagnostic characters: Labial palpi moderate, porrect ; 2nd joint with short dense scales beneath; 3rd joint short naked and obtuse. Maxillary palpi moderate, filiform. Hind tibiae with outer spurs one-thirds of inner spurs. Fore wing with vein Cu_1, M_3 and M_2 from lower angle of cell; vein R_5 closely approximated to R_{3+4} on basal point; R_{3+4} stalked; R_2 closely approximated to R_{3+4} towards base. Hind wing with Cu_1, M_3

and M_2 closely approximated at origin; vein Rs out of a M_1 near origin and anastomosing with $Sc+R_1$ for a short distance.

This genus has two species from India, However, of which only *P. balteata* (Fabricius) is reported as a pest of rice.

Pleuroptya balteata (Fabricius)

Fabricius 1798, *Ent. Syst.* Supplem., p. 457

Phalaena balteata Fabricius 1798, *Ent. Syst.* Supplem., p. 457

Sylepta balteata (Fabricius); Hampson 1898, *Proc. zool. Soc.* Lond., p. 178

Pleuroptya balteata (Fabricius); Shaffer *et.al.* 11996, *Check list of Lepidoptera of Australia, Pyralidae*, **4**: 196

Botys crocealis Duponchel 1831, *Hist. Nat. Lep. Fr.*, **8**(2): 365 (Synonymised by Hampson 1891).

Botys aurantiacalis Fischer von. Roeslerstamm 1840, *Ber. Erg. Schm.*, p. 213 (Synonymised by Hampson 1898)

Botys accipitralis Walker 1865, *List Spec. Lep. Ins. Coll. Brit. Mus.*, **34**: 1422 (Synonymised by Hampson 1898)

Botys aurea Butler 1879, *Ill. Typ. Spec. Lep. Het. Brit. Mus.*, **3**: 74 (Synonymised by Cotes & Swinhoe 1887-89).

Hapalia fraterna Moore 1884-87, *Lep. Ceylon*, **3**: 338 (Synonymised by Cotes & Swinhoe 1887-89)

Sylepta evergestialis Strand 1918[a], *Deutsche Ent. Zeitschr. Iris*, **32**: 51 (Synonymised by Shibuya 1928-29)

Diagnostic characters: General colour ochreous. Labial palpi silvery white below. Thorax with pale fan of scales. Legs silvery white. Fore wing broader; apex not produced; outer margin erect; antemedial line fuscous oblique; cell with a spot and discocellular lunule; postmedial line straight up to vein M_3, minutely dentate between vein M_3 and Cu_2; marginal band prominent and broad at apex, narrow near outer angle and again expand into a patch . Hind wing with discocellular speck; postmedial line highly bent outwards between veins M_3 and Cu_2; marginal band broad at apex then narrow and becoming maculate (Plate 9, figs. 128, 129, 130; Plate 19, fig. 245; Plate 25, figs. 296, 297).

Neuration

***Fore wing*:** Sc reaching costal margin at two-thirds length of wing; R_1 from cell at more than three-fifths distance of its length and reaching costal margin about five-sixths length of wing; R_2 from before upper angle of cell, very closely approximated to R_{3+4} and diverging at more than one-third distance of its length; reaching costal margin at five-sixths distance from end of cell to apex; R_3 and R_4 stalked; R_3 separated from R_4 at more than two-thirds distance of its length; R_5 well separated at base, curved upward and approximated to R_{3+4} and again curved downward towards margin; M_1 close to R_5 at base, diverging for a short distance and then start running towards margin; M_1 and M_2 quite apart and running near about parallel; M_2, M_3 and Cu_1 close and about equidistant basally, diverging distally; Cu_2 from cell at three-fourths distance of its length running parallel to Cu_1 towards margin; 2nd A reaching to margin; 3rd A after originating, curved upwards and join 2nd A before mid point of its length (Plate 5, fig. 59).

***Hind wing*:** $Sc+R_1$ reaching costal margin at very near to apex of wing; Rs just after its origin, anastomose with $Sc+R_1$ upto half of the length of wing, then separate and reaching apex; M_1 from upper angle of cell and at this point anastomosing with $Sc+R_1$, diverging distally; M_2, M_3 and Cu_1 close basally; Cu_1 very short distant to M_3, diverging distally; Cu_2 from cell at two-thirds distance of its length; 1st A, 2nd A and 3rd A complete; 1st A running parallel to Cu_2 towards margin (Plate 5, fig. 60).

Genitalia

***Male*:** Uncus large, base broad, apical portion finger-like lobe. Gnathos well developed, rostrum like, apex rounded, swollen posteriorly. Valva large, broad, uniformally covered with hairs; costal margin sclerotized; apex semirounded; from the base of the valva arises an elongated spine- like blunt process forming the clasper; saccullus sclerotized, broad at the base, narrow distally. Vinculum narrow, U-shaped.

Saccus conical. Aedeagus long cylindrical ; cornuti composed of a longitudinal scobinated patch containing a row of stout spines at base (Plate 14, figs. 191, 192).

Female: Papillae anales funnel like, heavily setose. Posterior apophyses short, about 0.5x as the anterior. Ductus bursae long tubular, basally slightly sclerotized; Copus bursae more or less rectangular with scobinate patches; signum composed of a tri-radiate spiny process, heavily sclerotized with margin saw like, and very small teeth (Plate 14, fig. 220).

Length: 11-17 mm

Wing span: 26-35 mm

Material examined: BIHAR: [4 exs., 21. IX. 1930, 1ex., 8. IX. 1932, 2 exs., 28, 29. VIII. 1932, 2 exs., 31. VIII. 1932, 2 exs., 1, 5. IX. 1922, 2 exs., 15. VIII. 1922, 1ex., 10.IX.1927, all on *Odino wodier,*, Rangi Coll.; 1ex., 6 .XII. 1926,at light, Pillai Coll.; 1ex., 9. IX. 1926, at light, Pillai Coll.; 2 exs., 21, 22. III. 1931, on *Salix tetrasperma,* Rangi Coll .; 1ex., -. IX. 1907, -. X. 1907, A.M. Coll.; 1ex., 16. IX. 1905, no other data, 1ex., 3. VII. 1914, at light, T.B.F. Coll.; 2 exs., 5, 6. VI. 1914, 1ex., 14. VII. 1914, 2 exs., 13, 18. X 1914, 2 ex., 14, 28. VII. 1915, 1ex., 11. IX. 1915, 1ex., 11. VIII. 1915, 2 exs., 5, 19. V.1915, 1ex., 24.VI. 1915, all Boy Coll.; 1ex., 7. X. 1915, at light. U. Bahadur Coll.; (all from Pusa). MAHARASHTRA: 1ex., -. X. 1909, Bassein Fort, Bombay AM.Coll.; MEGHALAYA: 3 exs., 5, 18, 27. IV. 1920, 1 ex., 10. V. 1920, all on *Quercus griffithii,* Fletcher Coll.; WEST BENGAL: 1ex., -. IV. 1908, Bagrhat, A.M. Coll.; 3 exs., 11, 13, 14. IX. 1925, *Odina wodier*, Daltaganj, Haq.Coll.; 1ex., Nagrispur, O. Lindrgren Coll. **[NPC]**

Distribution: Australia, China, Throughout India, Japan, Korea, Malaysia, Mynmar, Nigeria, S. Europe, Sri Lanka, Taiwan.

Subfamily Schoenobiinae

Diagnostic characters: Head with the frons rounded, Ocelli present. Proboscis very much reduced or wanting. Fore wing with 1st A short and generally developed near the outer margin. Hind wing with Rs and M_1 shortly stalked with small cross vein; 1st A developed near outer margin only.

Two genera could be examined under this subfamily which are recognized by the following key:-

Key to the genera of Schoenobiinae

1. Labial palpi 3 to 4 times of the length of head. Hind legs with outer tibial spurs two-thirds of the length of inner tibial spurs. Patagia of male without spreading hairs---------------------*Schoenobius* Duponchel
   Labial palpi 1 to 2 times of the length of head; hind legs with outer tibial spurs half of the length of inner tibial spurs ------------------------------ --*Scirpophaga* Treitschkle

Schoenobius Duponchel

Duponchel 1836, *Hist. Nat Lep. Fr.*, **10**: 8

Panalipa Moore 1884-87, *Lep. Ceylon*, **3**: 386 (Synonymised by Hampson 1895)

Microchoenis Meyrick 1887[b], *Trans. ent. Soc. Lond.*, p. 270 (Synonymised by Hampson 1895)

(Type species: *Schoenobius gigentelius* Schiffer mueller and Dennis)

Diagnostic characters: Labial palpi porrect; 2nd joint with short thick scales beneath, about twice the length of 3rd joint. Maxillary palpi dilated with scales. Antennae stout and pubescent. Hind tibiae with outer tribal spurs about two-third times length of inner spurs. Fore wing with the apex rounded in male and more produced in female; vein Cu_1 originating before lower angle of cell; veins M_2 and M_3 from lower angle of cell; R_5 straight and well separated from R_{3+4} which are stalked; R_2 free; R_1 free or coincident with Sc. Hind wing with Cu_1 from before lower angle of cell; M_2 and M_3 from lower angle of cell; M_1 and R_S from upper angle of cell, very shortly stalked; Rs anastomosing with $Sc+R_1$ beyond cell.

This genus has a single species from India which infests rice.

Schoenobius immeritalis (Walker)

Walker 1859[c], *List Spec. Lep. Ins. Coll. Brint. Mus*., **19** : 830

Dosara immeritalis Walker 1859[c], *List Spec. Lep. Ins. Coll. Brit. Mus*., **19**: 830

Panalipsa immeritalis (Walker); Moore 1884-87, *Lep. Ceylon*, **3** : 387

Microchoenis immeritalis (Walker); Meyrick 1887[b] , *Trans.ent.Soc. Lond*., p. 270

Schoenobius immeritalis (Walker); Hampson 1896 *Faun. Brit . Ind. Moths*, **4** (1): 47

Araxes decursella Walker 1863 [a], *List Spec. Lep. Ins. Coll. Brit. Mus*., **27**: 194 (Synonymised by Moore 1884-87)

Diagnostic characters: Body pale, straw-coloured, slender and white beneath. Labial palpi yellowish ochreous. Legs brownish ochreous. Fore wing yellowish-ochreous, narrow, acute, shining and without marking. Hind wing whitish, narrow, shining and without markings (Plate 10 figs. 131, 132, 133; Plate 19, fig. 246; Plate 25, figs. 298, 299).

Neuration

Fore wing **:** Sc reaching costal margin at more than a half of the length of wing; R_1 from cell at two-thirds of its length, coincident with Sc for a long distance, then separated near costal margin; R_2 separate and reaching near costal margin at more than two-thirds length of wing; R_{3+4} from upper angle of cell and stalked; R_3 separated from R_4 at less than half of distance from end of cell to margin of wing; R_5 well separated from R_{3+4} and M_1; M_2 and M_3 from lower angle of cell , close basally; diverging distally, Cu_1 distant from M_3; Cu_2 from cell at two-third of its length; 1st A slightly developed near margin; 2nd A present and reaching margin (Plate 5, fig.61).

Hind wing: $Sc+R_1$ reaching costal margin at about five-sixths length of wing; Rs just after its origin, anastomose with $Sc+R_1$ up to two-thirds length of wing, then separated and reaching to apex; M_1 from upper angle of cell and separate; M_2, M_3 and Cu_1 equidistant basally and diverging distally; Cu_2 from cell at about two-thirds of its length; 1st A slightly developed near margin; 2nd A and 3rd A feeble (Plate 5, fig. 62).

Genitalia

Male: Uncus short naked; tip narrow, nipple-shaped. Gnathos slightly shorter than uncus. Valva triangular, setose; costal margin well sclerotized; sacculus short and under developed; apical margin rounded. Vinculum broad, subrounded. Saccus U-shaped. Aedeagus small, slender, rod-shaped; cornutus absent (Plate 14, figs. 193, 194).

Female: Papillae anales conical, setose. Posterior apophyses shorter than anterior. Ductus bursae short, narrow, constricted and somewhat sclerotized. Corpus bursae membranous, elongate, club-shaped; signum well developed , slender (Plate 18, fig. 221).

Length : 4-7 mm

Wing span: 14-28 mm

Material examined: ASSAM: 1 ex., -.IV. 1908, Guahati, A.M. Coll.; BIHAR: 2 exs., Chapra, no other data; 1 ex., -. V. 1910, T.B.F. Coll.; 1 ex., VII. 1909, A.M. Coll.; 1 ex., 2. VIII. 1906, *on grass*, A. M. Coll.; 1 ex., 15. XII. 1915, Fletcher Coll.; 1 ex., 2. II. 1916, 3 exs., 25. II. 1916, all Fletcher Coll.; 2 exs., 19. II. 1929, R. Saran Coll.; 1 ex., 17. V. 1929, E. Hassan Coll.; 1 ex., 15. VI. 1906, D. R. Coll.; 1 ex., 28. VI. 1910, T. B. F. Coll.; 1 ex., 19. VI. 1906, *on weed*, A. M. Coll.; 1 ex., 24. XI. 1916, Fletcher, Coll.; 1 ex., 18. XII. 1920, *on grass*, no Coll.; 1 ex., 6.I. 1911, T.B. F. Coll.; 1 ex., 7. XI. 1914, *on weed*, R. S. Coll. (all from Pusa) KERALA: 1 ex., -. XII. 1914, *on rice*, Trivendrum, R. M. Pillai Coll.; KARNATAKA: 3 exs., -. II. 1907, AM Coll.; W. BENGAL: 2 exs.,-.X. 1906 Balasore, A.M. Coll 1 ex.,-.III. 1907, Balughat, G. R. D. Coll.; 1 ex., -. II. 1907, Balughat, A.M. Coll.; 1 ex., -. III. 1907 Balughat A.M. Coll.; 1 ex., -. II. 1907, Katni, A.M. Coll.; 1 ex.,-. VIII. 1917, Abbotabad, Mujtaba Coll.; [**NPC]**

Distribution: India (Kerala, West Bengal, Himachal Pradesh), Indonesia, Sri Lanka

Scirpophaga Treitschke

Treitschke 1832, *Die Scmetterlinge von Europa* , 9(1): 55

Apurima Walker 1863[a], *List Spec. Lep. Ins. Coll. Brit. Mus.*, **27** : 194 (Synonymised by Hampson1895)

Tryporyza Common 1960, *Aust. J. Zoology*, **8**(2): 339 (Synonymised by Lewvanich 1981)

(Type Species: *Phalaena praelata* Scopoli)

Diagnostic characters: Labial palpi porrect; 2[nd] joint longest. Maxillary palpi short and dilated with scales. Antennae filiform and weakly serrated. Proboscis very much reduced. Legs relatively long; hind tibiae with outer spurs about half of inner spurs. Abdomen long, anal tuft prominent in female. Fore wing whitish; apex more or less pointed in female than male; vein Cu_1 arises from before lower angle of cell; M_2 and M_3 originate from lower angle of cell; M_1 from above lower angle of cell and more or less parallel to M_2; M_1 approximated to R_5 basally; R_5 arises from upper angle of cell and separate; R_4 and R_3 stalked; R_2 free; R_1 free or coincident with Sc. Hind wing with vein Cu_1 from before lower angle of cell; M_3 arises close to M_2 from lower angle of cell and separate; M_1 and R_s originate together from upper angle of cell, afterwards Rs joins with Sc+R_1 near the base.

This genus has 13 species from India, of which 4 species are reported as pest of rice. A key for their identities is as follows:-

Key to the species of *Scirpophaga*

1. Fore wing with R_1 coincident with Sc for a short---------------*S. incertulas* (Walker)
- Fore wing with R_1 free from Sc--2
2. Hind wing of female with single frenulum-----------------------*S. fusciflua* Hampson

- Hind wing of female with double frenulum---3

3. Fore wing with vein R_5 equidistant to R_{3+4} and M_1 basally.
   Labial palpi 1.3 times to diameter of compound eye. Comparatively bigger --*S. nivella* (Fabricius)

- Fore wing with R_5 closer to R_{3+4} basally than M_1. Labial palpi 1.5 times to diameter of compound eye. Comparatively smaller --------------------------*S. giliviberbis* Zeller

Scirpophaga fusciflua Hampson

Hampson 1893, *Ill. Typ.Spec. Lep. Het. Coll. Brit. Mus.*, **9** : 167

Diagnostic characters: Male pale ochreous; female white. Labial palpi approximately equal to diameter of compoind eye. Hind legs with outer tibial spurs about half of inner spurs. Fore wing white to ochreous white; under side fuscous. Hind wing white; underside with costal area suffused with fuscus; frenulum single in both male and female. Anal tuft greyish white (Plate 10, figs. 134, 135, 136; Plate 19, fig. 247; Plate 25, fig. 300).

Neuration

Fore wing: Sc reaching costal margin at more than half of the length of wing; R_1 from cell at four-fifths distance of its length, reaching costal margin at two-thirds length of wing; R_2 separate , arising from cell before upper angle of cell, reaching costal margin at three-fourths length of wing; R_{3+4} from upper angle of cell and stalked; R_3 separated from R_4 at about half of distance of its length; R_5 closer to R_3+R_4 than M_1 basally diverging distally; M_1 from below upper angle of cell; M_2 and M_3 from lower angel of cell, close basally, diverging distally; Cu_1 from cell at before a little distance from lower angle of cell; Cu_2 from cell at four-fifths distance of its length, running parallel to Cu_1 and reaching margin; 1st slightly developed near margin; 2nd A developed, reaching apical margin (Plate 5, fig. 63).

Hind wing: Sc+R_1 reachning costal margin at near to apex of wing; Rs; just after its origin, anastomose with Sc+R_1 up to two-thirds length of wing, then separated and reaching to costal margin, near the apex of wing; M_1 from upper angle of cell; M_2 and M_3 from lower angle of cell, close basally, diverging distally; Cu_1 from cell just after lower angle of cell; Cu_2 from cell at about two-thirds of its length; 1st A slightly developed near margin; 2nd A and 3rd A complete (Plate 5, fig. 64).

Genitalia

***Male*:** Could not examine any male specimen for genitalic studies

***Female*:** Papillae anales funnel-shaped, longer than wide, densely setose. Anterior apophyses longer than posterior. Ductus bursae very short, strongly sclerotized basally. Corpus bursae round, membranous, strongly wrinkled; signum absent (Plate 18 fig. 222).

Length: 10-11 mm

Wing span: 16-27 mm

Material examined: PUNJAB: 4 ex., 22. VIII. 1997, *at light,* Ludhiana, Z. H. Khan Coll. **[NPC]**

Distribution: Afghanistan, India (Assam, Delhi, Haryana, Himachal Pradesh, Orissa, Tamil Nadu, Uttar Pradesh, West Bengal), Nepal, Taiwan, Thailand, Sri Lanka

Scirpophaga gilviberbis **Zeller**

Zeller 1863, *Chilonidarum* et *Crambidarum genera et species*, p.2

Niphadoses gilviberbis (Zeller); Common 1960, *Aust. J. Zool.*, **8** (2): 327

Scirpophaga gilviberbis Zeller; Lewvanich 1981, *Bull Brit. Mus. (Nat. Hist.)* (Entomology), London, **42** (4): 216

Diagnostic characters: Male dark fuscous; female white. Labial palpi with scales smooth; aproximately 1.5 times of the diameter of compound eye. Fore wing of male ochreous with sparse fuscous scales; of female white as in *S. nivella* (Fab.). Hind wing white; costal area and apex ochreous; frenulum single in male and double in female.

Anal tuft with outer hairs white and inner hairs brown (Plate 10 figs. 137, 138, 139; Plate 19, fig. 248; Plate 26, figs. 301, 302).

Neuration

Fore wing: Sc reaching costal margin at more than half of the wing; R_1 from cell at two-thirds length of wing; R_2 from upper angle of cell and very close basally to R_{3+4} and reaching costal margin at more than three-fourths length of wing; R_{3+4} stalked; R_3 separate from R_4 at one-thirds distance of its length; R_5 more close to R_{3+4} than M_1; M_1 quite apart from M_2 than R_5; M_2 and M_3 close basally, diverging distally; Cu_1 from cell near its lower angle; Cu_2 from cell at two- thirds distance of its length; 1st A slightly developed towards margin; 2nd A reaching margin (Plate 5, fig. 65).

Hind wing: $Sc+R_1$ reaching costal margin at about seven-eights length of wing; Rs just after its origin, anastomose with $Sc+R_1$ up to three-fourths of length of wing, then separated and reaching to apex of wing. M_1 from upper angle of cell; M_2 and M_3 very close basally from lower angle of cell, diverging distally; Cu_1 shortly distant from M_3; Cu_2 from cell at three-fourths of its length; 1st A, slightly developed near margin; 2nd A and 3rd A complete (Plate 5, fig. 66).

Genitalia

Male: Uncus long, slender. Gnathos equal to uncus, converging gradually. Valva elongated, rectangular; costal margin straight and parallel to saccular margin; apical margin rounded and setose. Vinculum U-shaped. Saccus short. Aedeagus long; one tridentate and two stout cornuti present (Plate 14, figs.195, 196).

Female: Papillae anales elongated, setose. Anterior apophyses longer than posterior. Ductus bursae comparatively short, sclerotized basally. Corpus bursae bladder like with small spines in basal two-thirds area; signum absent (Plate 18, figs. 223).

Length: 6-9 mm

Wing span: 14-25 mm

Material examined: ASSAM: 1 ex.,1. X. 1928, *at light*, Sibsagar, Bose Coll.; 1 ex., 12. X. 1928, *at light*, Tinsukhia, Bose Coll.; 3 exs., 16. X. 1928, *at light*, Dibrugarh, Bose Coll.; BIHAR: 1 ex., 20. VII. 1914, 1 ex., 9. VIII. 1914, 1 ex., 11. VIII. 1915, Boy Coll.; 1 ex., 12. VI. 1914, 1 ex., 29. II. 1916, 1 ex., 23. VI. 1916, 1 ex., 19. VIII. 1916, 1 ex., 20. IX. 1916, 1 ex,, 16. V. 1917, 1 ex., 20. II. 1927, (all Fletcher Coll.); 1 ex., 4. X. 1923, Peries Coll.; 1 ex., 15. III. 1926, Pillai Coll.; 1 ex., 9. V. 1927, Dwarka Prasad Coll.; 1 ex. 23. V. 1929., 1 ex., 29. XI. 1933, E. Hassan Coll.; 10 exs., 1. VI. 1932, 1 ex., 2. VI. 1932, *all on sugarcane*, no Coll.; 1 ex., 26.X. 1932, 1 ex., 30. V. 1933, Bose Coll.; 1 ex., 2. VIII. 1933, R. B. Misra Coll.; 2 ex., 13. III. 1935, N. Ayyar Coll.; (all from Pusa); 2 exs., 10. X. 1931, *on paddy*, Champaran, no Coll.; MEGHALAYA: 19 exs., no more data, Cherrapunji Native Coll.; TAMIL NADU: I ex., 22. VIII. 1921, 3 exs., 28. X. 1921, Palnis Kodai Kanal Fletcher Coll. **[NPC]**

Distribution: India (Assam, Bihar, Himachal Pradesh, Karnataka, Meghalaya, Orissa, Tamil Nadu, Uttar Pradesh, West Bengal), Indonesia, Myanmar, Pakistan, Singapore, Sulawesi, Thailand, Sri Lanka, Vietnam

Scirpophaga incertulas (Walker)

Walker 1863[a], *List. Spec. Lep. Ins. Coll. Brit. Mus.*, **27**: 143

Chilo incertulas Walker 1863[a], *List Spec. Lep. Ins. Coll. Brit. Mus.*, **27** : 143

Schoenobins incertellus (Walker); Hampson 1895. *Proc. zool. Soc.* Lond., p. 916

Tryporyza incertulas (Walker); Common 1960, *Aust. J. Zool.*, **8** (2); 340

Scirpohaga incertulas (Walker); Lewvanich 1981, *Bull. Brit. Mus.* (*Nat. Hist.*), (Entomology), London, **42** (4); 243

Catagela adonotalis Walker 1863[a], *List. Spec- Lep. Ins. Coll. Brit. Mus.*, **27** : 192 (Synonymised by Hampson 1895)

Schoenobins punctellus Zeller 1863, *Chilonidarum et. Crambidarum genera et species*, p.4 (Synoymised by Shiraki 1917)

Schoenobins minutellus Zeller 1863, *Chilonidarum Crambidarum genera et species,* p. 5 (Synonymised by Hampson 1895)

Tipanaea bipunctifera Walker 1863[b], *List. Spec. Lep. Ins. Coll. Brit. Mus.*, **28**: 523. (Synonymised by Shiraki 1917)

Chilo gratiosellus Walker 1864, *List Spec. Lep. Ins. Coll. Brit. Mus.*, **30**: 967 (Synonymised by Shiraki 1917)

Schoenobius bipunctifer ab. *quadripunctellus* Strand 1918[b], *Stettin ent. Ztg.*, **79**: 263 (Synonymised by Lewvanich 1981)

Diagnostic characters: Male brownish ochreous. Labial palpi pale yellowish ochreous. Maxillary palpi not well developed. Fore wing irrorated with dark scales and the veins slightly streaked with fuscous; black spot at lower angle of cell not conspicous; a marginal series of black specks. Hind wing ochreous white; frenulum double. Abdomen slender; anal end with thin hairs dorsally.

Female bigger than male. Maxillary palpi well developed and longer than in male. Fore wing bright yellowish-brown with a clear, single black spot at lower angle of cell; venation prominent. Hind wing white, often tinged with yellow towards outer margin, with single frenulum. Abdomen wide with tip covered with tuft of yellowish hairs (Plate 10 figs. 140, 141, 142; Plate 19, fig. 249; Plate 26, figs. 303, 304, 305, 306).

Neuration

Fore wing: Sc reaching costal margin at about two-thirds length of wing; R_1 from cell at three-fourths of its length, coincident with Sc for a short distance, then separate and reaching costal margin at more than two-thirds length of wing; R_2 from just before upper angle of cell, separate, reaching costal margin at more than three-fourths length of wing; R_{3+4} stalked; R_3 separated from R_4 at half of the distance of its length; R_5 equidistant to M_1 and R_{3+4}; M_2 and M_3 close basally, diverging distally; Cu_1 shortly distant from M_3; Cu_2 from cell at three-fifths of its length; 1st A slightly developed towards margin; 2nd A reaching margin (Plate 5, fig. 67).

Hind wing: $Sc+R_1$ reaching costal margin at near to apex of wing; Rs just after its origin, anastomose with $Sc+R_1$ up to two-thirds of the length of wing, then separated and reaching apex of wing; M_1 from upper angle of cell; M_2, M_3 and Cu_1 close and equidistant basally, diverging distally; Cu_2 from cell at two-thirds of its length; 1st A slightly developed near margin; 2nd A and 3rd A complete (Plate 5, fig. 68).

Genitalia

Male: Uncus long and slender with the tip blunt. Gnathos sclerotized and shorter than uncus. Valva rectangular; costal margin and saccular margin more or less straight; apical margin slightly bent in the middle with setae. Vinculum and saccus V-shaped. Aedeagus elongated; cornuti two, unequal, curved (Plate 14, figs. 197, 198).

Female: Papillae anales much longer than wide, setose. Anterior apophyses longer than posterior. Ductus bursae very much reduced and membranous. Corpus bursae elongated and three-fourths area from base minutely spined ; signum absent (Plate 18, fig. 224).

Length : 6-9 mm

Wing Span : 16-25mm

Material examined: ANDHRA PRADESH: Several exs., 26, 27. X. 1998 *at light,* all Hydrabad, all Z. H. Khan Coll.; ASSAM: 1 ex., 5.X.1928, Jhajhi, Bose Coll.; 1 ex., 12. X. 1928, Tinsnkhuia, 1 ex., 17. X. 1911, Sarbhog, C.C. G. Coll.; BIHAR: 1 ex.,-. IX. 1907, Chakradharpur, A.M. Coll.; 1 ex., 14. III. 1910, 1 ex. 23. X. 1914, 3 ex. 12, 14, 28. III. 1918, 1 ex. 28. III. 1923, *all on ric stubbles*, Bose Coll.; 1 ex. 11. V. 1910, D. N. P. Coll.; 1 ex., 14. X. 1910, 1 ex., 13. 10. 1911, 1 ex., 12. X. 1911, 2 ex., 8, 10. III. 1912, 2 ex., 11, 12. III. 1915, 1 ex., 8. IX. 1915, 4 ex., 2, 4, 9. X. 1915, 1 ex., 7. III. 1916, all T.B.F. Coll.; 1 ex., 3. III. 1011, 2 ex., -. IV. 1911. 1911, G.R. D. Coll.; 1 ex., 14. IX. 1915, Boy Coll.; 1 ex., 20. IX. 1923, 1 ex., 4. X. 1923, 2 ex., 30. X. 1923, 1 ex., 5. III. 1924, all Peries Coll.; 1 ex., 1. IV. 1924, Pillai Coll; [all from Pusa]; 1 ex., 16. X. 1911, C.C. G. Coll.; Katihar, 7 ex., 29. X. 1911, C.C.G. Coll.; Bhaumuhani, 1 ex., 28. X. 1911, Laksamju. **[NPC]**

Distribution: Afghanistan, Bangladesh, Bhutan, China, Hong Kong, Throughout India, Indonesia, Japan, Kampuchea Laos, Malayasia, Myanmar, Nepal, Pakistan, Philippines, Sri Lanka, Sulawesi, Taiwan, Thailand, Vietnam

Scirpophaga nivella (Fabricius)

Fabricius 1794, *Ent. Syst.*, **4**: 296

Tinea nivella Fabricius 1794, *Ent. Syst.*, **4** : 296

Crambus nivella (Fabricius); Aurivillius 1898, *Ent. Tidskr.*, p.169

Apurima nivella (Fabricius); Aurivillius 1898 , *Ent. Tidskr,*, p. 173

Scirpophaga nivella (Fabricius): Shibuya 1928-29. *J. Fac.Agr. Hokkaido Imp. Univ. Sapporo,* **22** : 61

Scirpophaga chrysorrhoea Zeller 1863, *Chilonidarum et Crammbidarum genera et species,* p.1 (Synonymised by Lewvanich 1981)

Scirpophaga auriflua Zeller 1863, *Chilonidarum et crambidarum genera et species,* P.2 (Synonymised by Caradja 1925 but wrongly cited as senior synonym of *S. nivella* (Fabricius))

Scirpophaga brunnescene Moore 1888, *Descriptions of new Indian lepidopetrous Insect from the Collection of the late Mr. W.S. Atkinson,* p. 225 (Synonymised by Lewvanich 1981).

Scirphaga euclastalis Strand 1918[b], *Stettin ent. Ztg.,* **79**: 262 (Synonymised by Lewvanich 1981)

Diagnostic characters: General colour ochereous. Labial palpi about 1.3x as the diameter of compound eye. Fore wing shining with four fuscous spots (3 on submedian fold and one on lower angle of cell; sometimes markings are absent; an oblique, irregular, uscous line extending inwards from costa near apex to third spot on submedian fold; a series of small fuscous dots along termen. Hind wing whitish; costal area and basal half ocherous; frenulum double in female and single in male. Anal tuft ocherous yellow (Plate 10 figs. 143, 144, 145; Plate 19, fig. 250, Plate 26, figs. 307, 308).

Neurations

Fore wing: Sc reaching costal margin at more than half of the length of wing; R_1 from cell at more than two-thirds of its length; R_2 separate and from just before upper angle of cell reaching costal margin beyond three-fourths length of wing; R_{3+4} stalked; R_3 separate from R_4 at more than half of distance of its length; R_5 equidistant to M_1 and R_{3+4}; M_1 quite apart from M_2 and more or less parallel to each other; M_2 and

M_3 not very close basally and diverging distally; Cu_1 distant from M3 and about parallel to it; Cu_2 from cell at two-thirds of its length; 2nd A reaching to margin 1st A short, visible slightly from margin (Plate 5, fig. 69).

Hind Wing: $Sc+R_1$ reaching costal margin at near apex of wing; Rs just after its origin, anastomose with $Sc+R_1$ upto two-thirds of the length of wing, then separated and reaching to apex of wing. M_1 from upper angle of cell; M_2 and M_3 running very closely for a very short distance from base, diverging distally; Cu_1 shortly distant from M_3 and running about parallel to it. Cu_2 from cell at three-fourths of its length; 1st A short and developed near margin 2nd A and 3rd A complete (Plate 5, fig. 70).

Genetialia

Male: Uncus triangular pointed and broad at apex. Gnathos highly sclerotized, triangular and longer than uncus. Valva simple, rectangular and densely setose; costal margin gradually concave; saccular margin convex; apical margin straight with setae. Vinculum elongate, round. Saccus short, U-shaped. Aedeagus long, slightly swollen near apex; two long and one slender cornuti present (Plate 14, figs. 199, 200).

Female: Papillae anales funnel-shaped, 3-4 times longer than wide, setose. Anterior apophyses longer than posterior. Ductus bursae short, broad, sclerotized, tapering anteriorly.Corpus bursae round, ball-like, membranous, smooth signum absent (Plate 18, fig. 225).

Length: 8-12 mm

Wing span: 21-30 mm

Material Examined : ASSAM: 1 ex., 9. X. 1928, *at light*, Barbhata, Bose Coll.; 1 ex., -. V. 1920, Fletcher Coll.; 1 ex.., 15. V. 1914, 1 ex., -. V. 1920, Fletcher Coll.; 2 exs., 14 . X. 1928., Tinsukhia, Bose Coll.; BIHAR 3 ex., -. XII. 1926, on leaves of *Heliocharis Plant*, Haq Coll.; 2 exs., 10. VI. 1915, *At light*, I ex., 2. V. 1921, boring stem of *Chkori* (H.), Rangi Coll.; 1 ex., 29. IV. 1922, boring stem of *Chikori* (H.), Rangi Coll.; 3 exs., -. 17, 9. VII. 1919, on *Saccharum arundiraeum*, no Coll.; 1 ex., 10. VIII. 1933, Lohat Factory, 1 ex., 27. X. 1911, *at light*, Laksam, C.C. G. Coll.; 1 ex., - X. 1901, C.W.M. Coll.; 2 exs., 29. IV. 1918, 2 exs., 19. IV. 1921, boring stem of *chikori*, Rangi Coll.; 1 ex., 29. X. 1919, Ram Saram Coll.; 4 exs., 3, 7, 9. X. 1926, Pillai Coll.; 1 ex., 29. VI. 1929, E. Hassan Coll.; 1 ex., 29. VIII. 1930, 1 ex., 3. IX. 1930, 2 exs., 9, XI. 1930, Gupta Coll; 3 exs., 24. X. 1932, 1 ex.,2. XI. 1932, all W. K. Wesly Coll.; 1 ex., 5. VII. 1933, 1 ex., 17. X. 1933, resting on rice (at light), H.N. Batra Coll; (all from pusa) MEGHALAYA: 2 exs., -. VIII-IX. 1919, 1 ex., -. VI. 1920, Fletcher Coll.; Shillong, UTTARANCHAL: 1 ex., 1. IX. 1930, Kathgodam, Samual Coll.; **[NPC]**

Distribution: Aru Island, Bangladesh, China, Fiji, Hong Kong, Throughout India, Indonesia, Japan, Malayasia, Myanmar, Nepal, New Guinea, Philippines, Singapore, Sri Lanka, Taiwan, Thailand, Timur, Vietnam.

CHAPTER-6

TAXONOMIC

DISCUSSION

TAXONOMIC DISCUSSION

The name Pyralidae was given for the first time by Stephens (1829), and it was followed by Hampson (1896). Later on, the entomologists were divided in giving this group a family or superfamily status. Imms (1925), Essig (1940) and Pruthi (1969) gave it a superfamily status, while Shibuya (1928-29), Comstock (1950), Amsel (1950) and Zimmerman (1958) the family status. Hampson (1896) divided it into 12 subfamilies namely Anerastiinae, Chrysauginae, Crambinae, Epipaschinae, Endotrichinae, Galleriinae, Hydrocampinae, Phycitinae, Pyralinae, Pyraustinae Schoenobiinae and Scopariinae. Shibuya (1928-29) divided it into 11 subfamilies i.e. Anerastiinae, Crambinae, Endotrichinae, Epipaschinae, Galleriinae, Hydrocampinae, Phycitinae, Pyralinae, Pyraustinae, Schoenobiinae and Scopariinae on the basis of presence and absence of proboscis, maxillary palpi, tuft of raised scales in the cell of fore wings, vein R_5 in fore wing and pectination of median vein on upperside in hind wings. Cosmotock (1950) divided this family into six subfamilies namely Crambinae, Galleriinae, Nymphulinae, Phycitinae, Pyraustinae and Pyralidinae. Minet (1982) recognised 25 subfamilies, but according to Shaffer *et al.*, (1996), all the subfamilies recognised by Minet (1982) are not accepted generally. The genera and species of the present study fall under five subfamilies namely Anerastiinae, Crambinae, Nymphulinae, Pyraustinae and Schoenobiinae. However in present study, the classification proposed by Hampson (1896) has been followed with slight modification.

Most of the earlier workers based their classification of Pyralidae to subfamilies on wing venation and wing armature; to genera on antennae, size and shape of frons, maxillary palpi, labial palpi, wings and legs; to species on colour of wing and its maculation. Very few used genitalic characters. Meyrick (1890) remarked " I have not used genitalia as generic character because after examining many species I have come to the conclusion that those characters which I have previously thought of value were not consistent either in families or in genera; often in closely allied species quite extraordinary differences occur".

Hudson (1929) commented that we should not rely on genitalia even for confirmation of the identity of different species. He pleaded that structure of genitalia may be profoundly modified in appearance by a very slight difference in the angle at which it is viewed. This effect of varying perspective will vitiate the accuracy of both drawing, photographs, and despite the greatest care, must produce many illusive differences. He further pointed out that six different taxonomists might reasonably draw absolutely identical neuration of a species, but it is very doubtful if six identical figures of genitalia could be made by six different taxonomists. Mueller-Rutz (1929) pointed out that the nature of palpi upturned, oblique or porrect, is not a characteristic feature for classification of this family into various subfamilies and reliance on this often led to superficial grouping.

Pierce and Metcalfe (1938) prepared a new classification of Pyralidae based on female genitalia but Marion (1952) disapproved this type of classification on the ground that they might be even less natural. He, therefore, suggested that all the natural characters are to be considered. There are other workers also who demonstrated the importance of genitalia in solving many of the identification problems. However, Tams (1926) opined that one should not depend entirely on the study of genitalia as those taxonomists who rush blindly, purely on the morphology of genitalic armatures, because one taxonomist has succeeded in solving his difficulties in this way, will undoubtedly result in confusion.

Keeping the above points in view, the present author has attempted to study all the morphological characters of the species along with their colour, maculation, neuration and male and female genitalia.

Subfamily Crambinae:

Under this subfamily 4 genera i.e. *Ancylolomia* Hubener (1 species), *Borer* Guenee, (1 species), *Chilo* Zincken (2 species) and *Chilotraea* Kapur (3 species) were examined.

Genus *Ancylolomia* Huebner includes a lone species i.e. *chrysograophella* (Kollar). This species was orginally described under genus *Chilo* Zincken which Zeller (1863) transferred under genus *Ancylolomia* Huebner. The present study conform this revision and consolidate placement of this species under genus *Ancylolomia* Huebner, because of vein R_5 being stalked with R_{3+4} in forewing whereas in *Chilo* Zincken R_5 is free from R_{3+4}.

Genus *Borer* Guenee include only one subspecies i.e., *sacchariphagus indicus* (Kapur). The above subspecies was described as a species of genus *Proceras* Bojer by Kapur (1950). Later on Bleszynski (1966) synonymised *Proceras* Bojer with *Chilo* Zincken and simultaneously transferred *sacchariphagus indicus* (Kapur) to *Chilo* Zincken. Fletcher and Nye (1984) stated that *Proceras* Bojer was incorrectly included by the earlier workers under Crambinae of Pyralidae, the placement being based on incorrect type species designation. According to them, type species of *Proceras* Bojer is *Pyralis saldonana* Fabricius and the genus *Procelata* Berthold of family Brachodidae and not Pyralidae. In view of this Arora (2000) included species *sacchariphagus* Bojer under genus *Borer* Guenee and *indicus* Kapur as its subspecies. The present study agrees with Arora (2000) in treating *Proceras indicus* Kapur, later on *Chilo sacchariphagus indicus* (Kapur) and then as Borer *sacchariphagus indicus* (Kapur).

Genus *Chilo* Zincken include two species *i.e., C. partellus* (Swinhoe) and *C. supperssalis* (Walker). Earlier *C. partellus* (Swinhoe) was known as *C. zonellus* (Swinhoe) but because the species *Crambus zonellus* Swinhoe 1884 was preoccupied by *Crambus zonellus* Zeller 1847, Bleszynski and Collins (1962) synonymised *zonellus* of Swinhoe 1884 with the *Chilo partellus* (Swinhoe). Arora (2000) mentioned that hind wings are with veins M_2 and M_3 stalked, but in the present investigation, in most of the specimens, these are free. Regarding female genitalia, Gupta (1958) observed that signum is absent but Agarwal and Tiwari (1969) found signum being present in form of a highly chitinized, small streak, surrounded by a weakly sclerotized area. However Bleszynski (1970) observed that signum is lamellate with median ridge. The present study confirms the findings of Bleszynski (1970).

Chilo suppressalis (Walker) was originally described under *Crambus* Fabricius, and Hampson (1896) for the first time transferred it to under genus *Chilo* Zincken. Labial palpi of this species are with them second segment less than 2x as long as the third when compared to *C. partellus* (Swinhoe), in which it is more than 4x long.

Genus *Chilotraea* Kapur included three species namely, *C. auricilia* (Dudgeon), *C. infuscatellus* (Snellen) and *C. Polychrysa* (Meyrick). Bleszynski (1962) synonymised genus *Chilotraea* Kapur with that of *Chilo* Zincken, and subsequently followed the same in 1970. However, Arora and Gupta (1999) revalidated the genus *Chilotraea* Kapur, because the vein R_1 in fore wing being confluent with Sc and frons smooth, subrounded and without corneous point. The present study confirms these finding that fore wings are with vein R_1 confluent with Sc and frons without corneous point as compared to R_1 being free and frons with corneous point.

Subfamily Anerastiinae:

This subfamily include two genera i.e. *Maliarpha* Ragonot with *M. separatella* Ragonot and *Saluria* Ragnot with *S. inficita* (Walker). The above two genera are separable from each other on the basis of presence or absence of vein M_3 in fore wing. In *Saluria inficita* (Walker), vein M_3 is present in fore wing, whereas in *Malirapha separatella* Ragonot, it is absent.

Subfamily Nymphulinae:

Under this subfamily there is only one genus *i.e., Parapoynx* Huebner of which two species *viz., P. fluctuoslis* (Zeller) and *P. stagnalis* (Zeller) included in the present study. Hampson (1896) illustrated the neuration of fore wing of *P. fluctuosalis* (Zeller) showing vein R_2 being stalked with R_{3+4}, whereas Arora (2000) illustrated it showing R_2 being free from R_{3+4}. The present author confined that *P. fluctuoslis* (Zeller)is with its forewing having R_2 free from R_{3+4}, whereas *P. stagnalis* (Zeller) has its R_2 stalked with R_{3+4}.

Subfamily Pyraustinae:

Under this subfamily 7 genera could be examined which are *Bradina* Lederer, *Mabra* Moore, *Cnaphalocrocis* Lederer, *Notarcha* Meyrick, *Pleuroptya* Meyrick, *Crypsiptya* Meyrick and *Herpetogramma* Lederer.

Genus *Cnaphalcrocis* Lederer included 5 species. *C. medinalis* (Guenee) was orginally described under genus *Salbia* Guenee by Guenee (1954) which was transferred to genus *Cnaphalocrocis* by Lederer (1863). Hampson (1896) mentioned that the labial palpi are upturned but Moore (1884-87) and Meyrick (1884) mentioned that these are porrect. However in the present study it is observed third segment of labial palpi is slightly curved, and it was confused being upturned by Hampson (1896).

This species is separable from rest of the species of *Cnaphlalocrocis* Lederer on the basis of vein R_1 in fore wing being stalked with vein R_2, whereas in remaining four species both the veins are free. In *C. poeyalis* (Boisdural), vein R_2 is free from R_{3+4} in fore wing. In *C. suspicalis* (Walker), *C. bilinealis* and *C. patnalis* (Bradely) fore wings are with vein R_2 very closely approximated to R_{3+4}. *C. suspicalis* (Walker) was earlier known as *Marasmia trapezalis* (Walker), till Bradely (1981) reported that *trapezalis* is not found in India but in Sri Lanka. According to him the Indian species involved is *Marasmia suspicalis* (Walker). Later on Shaffer *et.al.*, (1996) synonymised *Marasima* Lederer with *Cnaphalocrocis* Lederer, and cousequently *Marasmia suspicialis* (Walker) became *C. suspicalis* (Walker). From the present study, it appears that except *medinalis,* all other species transferred by Shaffer *et.al.*, (1996) from genus *Marasmia* Lederer to *Cnaphalocrocis* Lederer are not valid. However, since the present study includes only few species of genus, the new combinations proposed by Shaffer *et al.*, (1996) are accepted. In future, when some one will study the types of both the genera, the genus *Marasmia* Lederer may proved to be valid.

Genera *Bradina* Lederer and *Mabra* Moore were earlier placed under subfamily Hydrocampinae by Hampson (1896). However, Shaffer *et.al.*, (1996) transferred them to Pyraustinae. The present study consider it under Pyraustinae but suspect that in future, as a result of exhaustive study, these two genera may be replaced under Hydrocampinae, because its vein R_2 being stalked with R_{3+4} in fore wing.

Genus *Herpetogramma* Lederer with two species *i.e.*, *H. licarsisalis* (Walker) and *H. phoeopteralis* (Guenee), are separable from the species of Pyraustinae examined on the basis of veins M_2 and M_3 being approximated basally for a short distance in the hind wing.

Subfamily Schoenobiinae:

Two genera have been studied under this subfamily which are *Schoenobius* Duponchel and *Scirpophaga* Treitschke. These two genera are separable from each other on the basis of absence or presence of spreading hairs on patagia of male.

Scirpophaga gilviberbia Zeller was originally described by Zeller (1863). Common (1960) transferred it under his new genus *Niphadoses* Common but Lewvanich (1981) placed it under *Scirpophaga* Treitschke on the ground that vein R_1 of the fore wing did not anastomose with Sc and the scales on labial palpi are smooth and not spreading as in *Niphadoses* Common. The present study confirms the views expressed by Lewvanich (1981), in placing the above species under genus *Scirpophaga* Treitschke.

The species name *incertellus* was mentioned first in the index of Walker (1864) on page no. 1069 referring to page of description of *incertulas* under genus *Chilo* Zincken by Walker (1863[a]) on page no. 143. Fletcher (1923) without giving any evidence stated that *incertulas* was an error in manuscript or printing but corrected it as *incertellus* in index. Since name *incertulas* has priority over *incertellus* and there is no evidence of original misspelling, the name *incertulas* has been used here in confirmity with Lewvanich (1981).

Species *nivella* was orignally described under *Tinea* Denis & Schiffermueller by Fabricius (1794). Aurivillius (1898) placed it under *Apurima* Walker, but finally Shibuya (1928-29) transferred it under *Scirpophaga* Treitschke. The same was followed by Lewvanich (1981). The present study confirms its placement under genus *Scirpophaga* Treitschke. It is very interesting to note that, *Scirphoga expertalis* (walker) was always erroneously confused with that of *Scirpophaga nivella* (Fabricius), and has long been reported as a pest of sugarcane because of misidentification, but Lewvanich (1981) clarified that *S. nivella* (Fabricius) is basically a pest of rice.

CHAPTER-7

BIONOMICS

AND

ECOLOGY

STUDIES ON BIONOMICS AND ECOLOGY OF RICE LEAF FOLDER, *CNAPHALOCROCIS MEDINALIS* (GUENEE)

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BIONOMICS

The moths are nocturnal and usually appear soon after sun set. They are active fliers but during day time remain hiding under the leaves or cling on stems of paddy. When disturbed, they actively fly from one plant to another for a short distance.

MATING : Mating usually took place between dusk and night and was not observed during day time. The males are attracted towards the female by pheromone secreted by the female. After reaching the female, the male flaps its wings vigorously, encircles for some time before mounting from the rear. Copulation lasts for 10 to 12 minutes and about 5 minutes reported by Prakash and Rao (1998) and Velusamy and Subramanium; (1974), respectively. But the present author could not success to observe the mating.

PRE-OVIPOSITION, OVIPOSITION PERIODS AND FECUNDITY: The pre-oviposition period (Table 1) was found to vary from 1 to 2 days with an average of 1.5 days. Eggs laid singly or in groups of 2 to 9 in a single line on both surfaces of leaves, but very often on the upper surface, in between the veins, parallel to the midrib. Occasionally, eggs laid on leaf lamina and leaf sheath. The total number of eggs laid by a female during the entire oviposition period varied from 68 to 94 eggs with an average of 82.33 eggs. Oviposition period lasted 2 to 3 days (Table 1), with an average of 1.67 days. The pre-oviposition, oviposition and fecundity were found to be 1 to 2 days, 1 to 2 days and 42 to 72 eggs with an average of 56 eggs, respectively, by Velusamy and Subramaniam (1974). These observations agree with those of Godase and Dumbre (1982) Prasad *et al.,* (1993), they reported preoviposition, Oviposition and fecundity as 3 and 1 to 2, 3 and 1 to 3 days and 56 and 76 to 103 eggs, respectively. Lingappa (1972) reported it an average of 100 ± 25 eggs. Pre-oviposition and fecundity were 2 to 3 days and 68 –182 eggs, reported by Prakash and Rao (1998).

OVIPOSITION BEHAVIOUR: The female first moves up and down on the leaves for about 10 minutes and finally selects a suitable place for ovipostion. After selecting the place the moth bends its abdomen and eggs are normally deposited on the upper surface in between the veins of leaves. The eggs, occasionally, are also laid on lower surface. Eggs are laid singly as well as in groups of 4 to 6 (Velusamy & Subramanium, 1974). In present investigations the author has also observed as about same.

EGG: The eggs, when freshly laid are hexagonal, jelly like, translucent with a reticulate upper surface. When matured become ovoid and yellowish white, measuring 0.65 to 0.85 mm in length and 0.35 to 0.40 mm in breadth. Just before hatching, the head can be seen through the transparent chitinous shell as a black structure and the proximal end of egg for about two-thirds of its length being more opaque than the rest (Plate 27. figs. 309, 310)

INCUBATION PERIOD AND HATCHING: The incubation period varied from 5.0 to 7.0 days, the more common being 6 days (Table 2). Eggs turn black prior to hatching and larvae are clearly seen occupying the full space of the egg. The incubation period reported by Abraham (1958) and Lingappa (1972) were 6 to 7 and 5-0.7 days, respectively, While Yadava *et al.*, (1972), Velusamy and Subramaniam (1974), Prashad *et al.*, (1993) and Godase and Dumbre (1982) observed it to be 6.89 days, 6 to 8 days, 4 to 5 days and 6 to 8 days, respectively.

LARVAL DEVELOPMENT : The larvae moulted five times before it pupates (Table 2). Developmental period of Larvae ranged from 19 to 27 days. These observations confirmed those of earlier workers i.e. Velusamy and Subramaniam

(1972) and Prashad *et al.*, (1993). While Lingappa, (1972) Yadava *et al.*, (1972) and Godase and Dumbre (1982) reported it ranged between 15 to 17 days.

FIRST INSTAR: The newly hatched larvae are whitish with a black head and measured about 1.5 mm in length and 0.25 mm in breadth. The mouth parts are well developed with black mandibles, thin labrum and labium. In this instar, larvae are gregarious and do not fold the leaves, they scrape, chlorophyll in groups of 2-4. As they feed on the chlorophyll, their body colour turn greenish. There are a number of brown lines on the body. The body is elongated and gradually tapers towards the posterior end. Five distinct setae are present in the last abdominal segment. The spiracles are not clearly visible in this instar. Before moulting in the second instar they grow to 3.45 mm in length and 0.44 mm in breadth (Plate 27, figs. 311, 312). The duration of this instar varied from 3.0 to 5.0 days. These observtions closely agree with Velusamy and Subramaniam (1974). Godase and Dumbre (1982); Prasad *et al.*, (1993) and Prakash and Rao (1998). They reported it 3 to 4 days, 3 days, 3 to 4 days and 3 to 4 days, respectively.

SECOND INSTAR: Second instar larvae is green and its epicranial suture distinct; other characters same as in the first instar. Newly moulted larvae measured 3.5 mm in length and 0.5 mm in breadth. Duration of the second instar varied from 4 to 5 days with an average of 4.5 days. The length of larvae increased to 6.5 mm and breadth to 0.65 mm, before moulting (Plate 27, figs. 313, 314). These larvae are capable of initiating binding of leaf edges with silken strand; silken threads are fixed by swinging the head back and forth between both the margins of leaves, while the anal and abdominal prolegs grasp the leaf surface, thus stitching the two edges of the leaf together. The folded leaf is produced in about 10 minutes, and Barrion *et al.*, (1991) observed it to be 4-13 minutes.

THIRD INSTAR: It is slightly dark green owing to the body contents clearly visible through the cuticle. Spiracles and body segments are distinct. Brownish, semicircular patches are observed on either side of the mid dorsal line of the pronotum; other characters similar to the second instar. Freshly moulted larvae measure 7.0 mm in length and 0.75 mm in breadth (Plate 27, figs. 315, 316). Duration of this instar varied from 3 to 5 days days with an avarage 4.0 days. When the larvae are ready to moult into the next instar, measured 11.5 mm in length and 1.0 mm in breadth. Present findings agree with the observations of Velusamy and Subramaniam (1974); Prashad et al., (1993) and Prakash and Rao (1998), they reported that the length and breadth varied between 7.0 to 11.0 mm and 0.53 to 1.0 mm, respectively, and duration of this instar ranged between 4.0 to 5.0 days.

FOURTH INSTAR: The body colour of this instar is dark green, and other morphological features are same as in the third instar. The larvae become voracious feeders and actively fold the leaves. Freshly moulted larvae measured 12.5 mm in length and 1.25 mm in breadth, Brown spots on the head and the prothoracic shield become prominent, epicranial suture is very distinct (Plate 27, figs. 317). The duration of this instar varied from 4.0 to 6.0 days with an average of 5.0 days. Before moulting to fifth instar the larvae measured 15.0 mm in length and 1.75 mm in breadth. Godase and Dumber (1982), and Prakash and Rao (1998) also reported similar observations.

FIFTH INSTAR: It is yellowish green with an orange tinge on the dorsal side except the head which is light brown. The abdomen tapers distally; short and long setae are present on the body and appendages; abdominal segments and spiracles become more prominent. These larvae measures 16.25 mm in length and 2.0 mm in breadth, when freshly mounted. Duration of this instar varied from 5.0 to 6.0 days. The larvae turns pinkish and become sluggish before pupation, and measure 19.5 mm in length and 2.5 mm in breadth (Plate 27, figs. 318, 319). The duration of this instar reported by Velusamy and Subramanium (1974), and Godse and Dumbre (1982) are similar to the observations of present study, 5.0 –6.0 days, while Prashad *et al.*, (1993) observed it 4.0 to 5.0 days and the body length as 23.0 to 25.0 mm.

NATURE OF DAMAGE AND LARVAL BEHAVIOUR: The larvae fold the leaves, remain inside and scrap green tissue between the veins which make the leaves white and papery. Initially, the first instar larvae fed by scraping the leaf tissue for one to two days, then secreted a silken thread and fastened the edge of the leaf tips. Generally, the scraping is done initially in the middle portion of the leaf blade and subsequently extended to either end. The presence of caterpillar inside the leaf roll is indicated by the green excretory matter left behind the caterpillar during its progress of feeding. Scraping is done only length wise in the leaf surface but no such scrapping has been observed across the surface (Plate 27, figs. 321, 322). The larvae which migrated to the leaf margins curled some portion of leaf margin and struck it with a silken thread to the leaf lamina. Generally, the first and the second instar larvae prepared leaf roll in this manner and fed inside. Affected leaves showed white streaks on leaf lamina due to destruction of chlorophyll.

Four types of leaf rolling were observed, in the first type, the edges of leaf are fastened together in the middle region. In the second type, the tip of the leaf is fastened to the middle portion of the leaf blade. The third type is almost similar to the second type excepting that the leaf is fastened together in a twisted manner and in the fourth type the adjacent leaves are fastened together after rolling each leaf. The first type was more common and second type, folding is normally seen in early stages of the crop growth while other types are common in 70 to 90 days old crop during panicle initiation and milky stage. It is also observed in present study that the damage was invariably severe near the bunds than in the centre of the field.

PUPATION AND PUPA: Pupation takes place within the leaf fold, and also noted to take place between the leaf sheath and stem. The body segmental constrictions become prominent, body length is shortened, measured 12.0 to 14.0 mm in length and 2.75 to 3.00 mm in breadth (Plate 27, figs. 320). At this stage larvae cease to feed and make thin silken cases over themselves in leaf roll after pre-pupal moult. Before pupation, it makes an exit hole and covers with a thin webbing. The white silken cocoon is closed at the upper end and the lower end is rounded and bag like. Pupation always takes place mostly in the middle portion of the leaf. The duration of prepupal stage varied from 1.0 to 2.0 days with an average at 1.5 days (Table 2).

Pupae are yellowish brown when newly formed but gradually turn reddish brown. It is usually covered with a thin, white, silken cocoon. At the later stage, the pupae become brown and the wing pads are darker than the rest of the body. One or two days before emergence, the wing pattern of the adult becomes visible. The adult emerges by cutting through the pupal skin at the anterior portion. The pupal length ranged between 8.0 to 12.5 mm and breadth ranged between 2.5 to 3.0 mm (Plate 27, figs. 323, 324, 325). The duration of pupal period varied from 6.0 to 8.0 days with an average of 7.0 days (Table 2) . Those findings agree with those Godase and Dumbre, (1982) and Prakash and Rao (1998); prepupal and pupal periods averaged 1.0 to 2.0 days and 6.0 to 8.0 days, respectively. Prasad *et al.,* (1993) and Heinrich (1994) also observed that the pupal period is 6 to 8 days, as reported earlier.

ADULTS: The adult has a slender body, golden yellow with black wing margins in the apical region. Males are brighter than the females. There are three dark brown zig-zag transverse lines on each fore wing. The anterior one is longer and extended from the costal margin to the anal margin. The middle one is short and comma (,) like, curved outwards. The inner one is shorter than the outer one and do not reach the anal margin. In the hind wing, there are two brown transverse lines, outer being mush longer than the inner. The males have a tuft of black androconial, scales on the costal margin and a thick back hair tuft on the fore tibiae. Abdomen elongated and uniformly tapers towards the end, with tuft of hairs at the tip in the male moth while in the female the abdominal tip is broad and rounded (Plate 23, figs. 278, 279). The male and female wing span measures 15.0 to 16.0 mm and 15 to 17 mm, respectively and the body length 8.0 to 10.0 mm, and 6.0 to 8.0 mm, respectively. The male and female lives for 2.0 to 4.0 days and 6.0 to 9.0 days, respectively with an average of 3.0 days and 7.5 days respectively.

Life span from egg to adult of male is 33.0 to 48.0 days with an average to 40.5 days whereas that of female varied from 37.0 to 53.0 days with an average of 45.0 days. These findings are similar to that of Abraham (1958); Lingappa (1972); Velusamy and Subramanium, (1974); Godase and Dumbre (1982).

Table 1: Preoviposition , Oviposition and fecundity of *Cnaphalocrocis medinalis* (Guenee)

S. No.	Number of eggs laid (Days after release)					Fecundity	Preoviposition period (Days)	Oviposition (Days)
	1	2	3	4	5			
1	-	-	45	24	16	85	2	3
2	-	38	22	8	-	68	1	3
3	-	-	50	44	-	94	2	2

Table 2: Duration and Size of different life stages of *Cnaphalocrocis medinalis* (Guenee)

S. No.	Stage	Duration (Days)			Length (mm)	Mean	Width (mm)	Mean
		Minimum	**Maximum**	**Average**				
1.	Egg	5.0	7.0	6.0	0.65 - 0.85	0.75	0.35 – 0.40	0.37
2.	1st Instar	3.0	5.0	4.0	1.5 – 3.45	2.47	0.25 – 0.44	0.34
3.	2nd Instar	4.0	5.0	4.5	3.5 – 6.5	5.00	0.5 – 0.65	0.58
4.	3rd Instar	3.0	5.0	4.0	7.0 – 11.5	9.25	0.75 – 1.00	0.88
5.	4th Instar	4.0	6.0	5.0	12.5 – 15.0	13.75	1.25 – 1.75	1.50
6.	5th Instar	5.0	6.0	5.5	16.25 – 19.5	17.87	2.00 – 2.5	2.25
7.	Larva	19.0	27.0	23.0	-	-	-	-
8.	Pre-pupa	1.0	2.0	1.5	12.0 – 14.0	13.00	2.75 – 3.00	2.87
9.	Pupa	6.0	8.0	7.0	8.0 – 12.5	10.25	2.5 – 3.0	2.75
10.	Adult Male	2.0	4.0	3.0	8.0 - 10.0	9.00	15-16 wing span	15.50
	Adult Female	6.0	9.0	7.5	6.0 – 8.0	7.00	15-17 wing span	16.00
11.	**Total Male**	**33.0**	**48.0**	**40.5**	-	-	-	-
12.	**Total Female**	**37.0**	**53.0**	**45.0**	-	-	-	-

MONITORING OF POPULATION THROUGH LIGHT TRAP AND NET SWEEPING IN RELATION TO WEATHER FACTORS:

Studies on the effect of weather factors on the population buildup of leaf folder (LF), *Cnapholocrocis medinalis* (Guenee) through light trap and net collection were carried out to determine the period of abundance, at Delhi, over four years (1997-20.00). During the crop season of 1997, results indicated (Table 6.), that the higher moth numbers were trapped in the month of October, exhibiting the peak activity in the first week, followed by September and October. While the trap catches begun in the first week of June, when the crop was in nursery stage, at this time the trapped moths number was very low (Fig. 326). In the month of July and August, the population ranged between 38 to 56 and 65 to 86, respectively. In case of net sweeping, almost same results were obtained. Maximun moths were collected during October, followed by September and November. While in the month of August and July also, considerable number of moths were collected by net sweeping.

Results indicated during the crop season of 1998, (Table 7.), maximum number of moths were trapped during first week of November followed by third, fourth and second week of October. In the month of July, August and September there was cosidrable number of moths were also trapped, while the trap catches begun in the first week of June, whereas in case of net sweeping also same results were obtained. Maximum number of moths were collected during October followed by September, November and August (Fig. 27).

In 1999, that the maximum number of moths were caught during the first week of October folowed by August and September (Table 8). In June and July moths number was very low and almost similar results were obtained in November. In case of net sweeping results indicated, that the highest moths number were recorded during October followed by November and September, whereas in August the population was low and in June and July it was very low, not cosiderable (Fig. 328). During this crop season the population was low in light trap collection as well as net sweep collection, perhaps this is due to the very low rainfall in the months of September and first week of October and from second week of October and November there was no rainfall.

In 2000, highest number of moths were trapped during first week of October, and in the third week of August (Table 9). While in September and November, there was less number due to no rainfall, high morning relative humidity and long sunshine hours. In case of net sweep collection, the maximum number of moths were observed during October followed by September, November and August whereas in June and July it was very low (Fig. 329).

Studies on the effect of weather factors on the population buildup of leaf folder, *Cnaphalocrocis medinalis* (Guenee), through monitoring by light trap and net sweep collection for four years indicated that the population was low June and July; at this period the weather prameters *viz.,* maximum and minimum temperature; rainfall, morning and evening relative humidity; and sunshine hours ranged between 31.72-43.45^0 C and 22.5-35.81^0 C; 0.0-22.14 mm, 52.57-91.87 per cent and 23.71-78.12 per cent; and 1.41-8.83 hrs., respectively. Relatively more number of moths were trapped during October followed by September, November and August. The weather prameters *viz.,* maximum and minimum temperature; rainfall, morning and evening relative humidity; and sunshine hours during this period were ranged between 25.75-35.23^0 C and 15.46-23.32^0 C; 0.0-4 mm, 74.62-91.12 per cent and 33.57-76.25 per cent; and 3.51-8.66 hrs., respectively. It is observed that the relative humidity in the morning and evening positively influenced the light trap collection, while relative humidity at morning and sunshine hours positively influenced the net sweep collection. These findings are in concordance with the results obtained by Bhatnagar and Saxena (1999), who reported that the highest numbers of moths were trapped during October, and exhibiting their peak activity in the last week. Qadeer *et al.,* (1990) reported that the catches of moths started from July and it reached its peak during August and September, and during October and November, It was low.

When the stage of the crop is taken into account, maximum moth population or peak activity was observed in the month of October, when the crop was at milky stage *i.e.,* 80 to 95 days after transplanting. During early stage of crop, about 40 to 60 days after transplanting, the population was found low, while at 70 to 80 days after transplanting, the insect population was considerable, and at this time the crop was at booting and panicle stage.

The correlation studies between light trap and net sweep collection with weather parameters (maximum temperature, minimum temperature, rainfall, relative humidity at morning, relative humidity at evening and sunshine hours) were carried out to find the influence of weather parameters on population buildup of leaf folder (Table 3.). Among the weather parameters, maximum temperature, minimum temperature and relative humidity at morning were highly significant (P< 0.01); maximum temperature and minimum temperature had negative impact on the population buildup; relative humidity at morning had positive impact on the population buildup. Thus, low temperature and high morning relative humidity are favorable for leaf folder population buildup.

TABLE 3. Correlation between light trap and net sweep collection with weather parameters

WEATHER PARAMETERS	LIGHT TRAP	**NET SWEEP**
Maximum temperature	-0.399612**	-0.463454**
Minimum temperature	-0.203965**	- 0.273679**
Rainfall	-0.114075	- 0.177701**
Relative humidity (morn.)	+0. 279817**	+0.0295303**
Relative humidity (even.)	+0. 112269	-0.0.08258
Sunshine hours	-0.013282	+0.046396

[(* *) indicate significance at 1 per cent level of significance and (*) indicate significant at 5per cent level of significance.]

The correlation between net sweep collection and light trap collection was found to be very high (0.866), indicating that either one of them is enough to monitor the leaf folder population dynamics field conditions.

The relationship was also quantified using simple regression and results are given below.

Light trap population]= 22.33435** + 1.013407** (Net sweep)

(2.064275) (0.060278)

R^2 = 0.750430, P< 0.0.01

[Figures in parenthesis are standard error and * * indicate significance at 1 per cent level of significance and * indicate significant at 5 per cent level of significance.]

Both the intercept term and the regression cofficient are highly significant. Thus this can be use as a formula to estimate light trap collection based on the net sweep collection or vice-versa.

It can be concluded that the dry and longer sunshine hours, and light rains with two or three cloudy days and sudden drop in the day and night temperature appear to have triggered their peak activity during October to November. The studies undertaken by Manjunath (1982), Reddy and Mishra (1983) and Bhatnager and Saxena (1999) had also reported similar results.

STUDIES ON INFLUENCE OF WEATHER PARAMATERS ON LARVAL POPULATION AND DAMAGE

The effect of weather factors on the larval population of leaf folder (LF), *Cnapholocrocis medinalis* (Guenee) and its damage under Delhi conditions was studies over four years (1997-20.00). During 1997 crop season, the incidence started in a moderate level in July; infestation and larval population per hill varied between 2.5 to 44.0 per cent and 0.5 to 10.6 larvae per hill; July immediately after transplanting larval population and per cent leaves were 0.5-0.75 and 2.5-4.5, respectively. In the early stages of crop, the leaf blades being not as broad, infestation is not visible. After 35 days after transplanting (August), the damage become quite apparent, and the larval population and the percentage damage were 0.75-2.8 and 6.5-12, respectively. Infestation reached its maximum in October, *i.e.*, 95 days after transplanting, when the larval population and the per cent damage reached levels of 8.0-10.6 and 33.0-44.0, respectively. In November and September (Table 10), the larval population and per cent damage were 2.8-7.5 and 21.5-30.5, respectiely, and 3.0-8.25 and 14.0-28.0, respectively (Fig. 330). In October the activity of pest decreases, perhaps due to the reason that no more leaves are produced. Chandragiri *et al.*, (1974) also reported higher leaf damage (30.32 per cent) at heavy doses of nitrogenous application. The same was observed by Subbiah and Muracharan (1974). Whereas Nadarajan and Sakaria (1988) reported as much as 55-90 per cent leaf damage due to the repeated use of carbofuran as compared to control. Panda and Shi (1989), reported 33 larvae/ hill from the plots treated with carbofuram as against 20.4 larvae/ hill in untreated plots.

The data from the crop season of 1998, show (Table 11), that the infestation and larval population varied between 2.5- 25.4 per cent and 0.25-6.5, respectively. Shah (1990) reported that 55-92 per cent plants were fed. However, significant yield reduction was reported at 10 per cent leaf folder damage in Gujarat and Tamil Nadu. The minimum leaf damage and larval population were during the first week of July *i.e.,* 2.5 per cent and 0.25 , respectively, followed by third week 2.5 per cent and 0.5, respectively and second week 3.5 per cent and 0.5, respectively of August. The maximum infestation and larval population being 25.4 per cent and 6.5, respectively in fourth week of October followed by third week of October, *i. e.,* 17.2 per cent and 4.5, respectively and first week of November *i. e.,* 16.2 per cent and 4.5, respectively. Whereas in the month of September the percent of damaged leaves and larval population were also quite apparent, varied between 5.0-8.4 and 1.0-2.5, respectively (Fig. 331). Meteorological parameters, *viz.,* maximum temperature, minimum temperature, rainfall, relative humidity at morning, relative humidity at evening and sunshine hours at the peak infestation and larval population were 27.01^{0}C, 15.95 ^{0}C, 0.0 mm, 83.62 per cent, 36.87 per cent and 8.66 hrs., respectively; while at the lowest infestation the meteorological parameters were 34.35- 22.85 ^{0}C, 1.6 mm, 67.12 per cent, 57.37 per cent and 1.49 hrs. , respectively. Sachan (1992) reported outbreak in the monsoon period on rice in valleys of Uttar Pradesh, to appear in July-October, population peaks to early August to late September. Leaf damage averaged 45-86 per cent and high yielding varieties suffer more damage than local tall ones; while Sudhakar *et al.,* (1993) studied the effect of nitrogen on the incidence of leaf folder, *Cnaphalocrocis medinalis* in different varieties. At 60 days after transplanting, the damage was 12.19 per cent and 25.01 per cent in the least susceptible and the most susceptible cultivars, respectively.

In the crop season of 1999 (Table 12), the per cent infestation and larval population ranged between 1.28-20.25 and 0.25-6.0, respectively. The maximum percent damage and larval population were observed to be 20.25- and 6.0, respectively during the fourth week of October, when the meteorological parameters, *viz.*, maximum temperature, minimum temperature, rainfall, relative humidity at morning, relative humidity at evening and sunshine hrs. were 32.62 ^{0}C, 16.07 ^{0}C, 0.0 mm, 80.62 per cent, 39.12 per cent and 8.0 hrs., respectively; while at the lowest infestation and larval population, the meteorological parameters were 33.0 ^{0}C, 24.53 ^{0}C, 22.14 mm, 91.5 per cent, 82.0 per cent and 1.72 hrs., respectively. In August the per cent damage and larval population increased to become visible, *i. e.*, 3.08-6.0 and 0.5-1.8, respectively. Where as in September, (65-80 days after transplanting), the damage and larval population became quite apparent, *i.e.*, 6.5- 8.6 and 1.5-3.0, respectively (Fig. 332). While in the month of November, when the crop was near to harvest, the per cent infestation and larval population suddenly decreased to reached between 9.4-3.5 and 2.0-4.5, respectively from the highest 20.25 and 6.0, respectively, which was due to maturing of the crop. Prasad *et al.*, (1995[b]) observed that the percent damage ranged between 52 to 87.4 per cent and 5.6 to 20.3 percent in different cultivars, respectively. Singh *et al.*, (1995[b]) determined that the 56.5 per cent damage caused 40-80 kg ha yield loss; when 10 per cent damaged could safely be considered as a desirable economic threshold. Devanesan *et al.*, (1995) also reported 11.17 to 35.45 per cent damage.

The data of the crop season of 2000 (Table 13), showed that the per cent damag and larval population ranged between 0.5-18.0 and 0.1-5.5, respectively. The highest damage and larval population were recorded 18.0 and 5.5, respectively during third week of October (80-90 days after transplanting), At this time meteorological parameters, *viz.*, maximum temperature, minimum temperature, rainfall, relative humidity at morning, relative humidity at evening and sunshine hours were 34.56 ^{0}C, 16.66 ^{0}C, 0.0 mm, 84.87 per cent, 42.5 per cent and 5.73 hrs., respectively; while at the lowest infestation and larval population in the mid July, 15 days after transplanting, the meteorological parameters were 31.72 ^{0}C, 25.32 ^{0}C, 13.02 mm, 91.87 per cent, 77.87 per cent and 2.65 hrs., respectively. In July and till second week of August, the infestation and larval population were low due to early stage of crop. The percent damage and larval population became quite apparent from the mid August and continuous increases was seen till the third week of October. In September, (65 days after transplanting) per cent damage and larval population were 5.6-8.0 and 1.2-2.0, respectively (Fig. 333). In November, (110 days after transplanting) damage and larval population declined very quickly and reached 10.0-13.5 per cent and 0.5-2.0, respectively. Kumar *et al.*, (1996) studied the population dynamics in relation to stage of the crop and weather factors. It was reported that the infestation varied from 1.4 to 33.2 per cent from July to October, and percent of infested leaves having live caterpillars varied from 8.59 to 82.43 per cent, maximum was during August and September. The minimum infestation recorded during July (1.8-2.9 per cent) and in the third and fourth weeks of October (1.4-6.3 per cent), and the maximum during September (17.9-33.2 per cent) followed by August (7.6-16.2 per cent). The peak period of infestation coincided with the panicle initiation stage. Ramaraju and Natarajan (1997) reported that the damage was very high in different cultivars, infestation ranged from 23.5 to 65.5 per cent. Dash *et al.*, (1997) reported 19.2 per cent damage under untreated conditions. Mishra *et al.*, (1997) reported that the maximum infestation occurred during September transplanting. Irrespective of dates of planting, incidence was higher during 7-9 weeks after planting.

The studies on the per cent damage and larval population in relation to weather factors and stage of crop for four years (1997-20.00) revealed that the per cent damage and larval population ranged between 0.5-44.0 and 0.1-10.6, respectively. Singh and Sharma (1998) observed that the per cent damage and larval population per 10 damage ranged between 0.55 to 49.7 and 1.66 to 5.5, respectively. Korat *et al.*, (1988) reported 10.35 per cent damaged leaves in Gujarat, he also reported that the damaged leaves ranged from 3.94 to 9.33 percent in different varieties. Whereas Anonymous (1998) reported that the per cent damage in different varieties at Nawagam and Coimbatore 10.4- 13.7, at Ludhiana and Meruteru averaged 12.5 per cent and at Patna average 25 per cent, while Sontake *et al.*, (1999) recorded 17.4 and 14.6 per cent damaged leaves on Jaya and Jagati in summer, respectively. Khan *et al.*, (1999) recorded the maximum per cent damage up to 28.4 per cent and larval count of

6.6 per hill in Pusa Basmati. Anonymous (1999) reported that the incidence was very high at Kapurthala (98.0 per cent damaged leaves) and Ludhiana (94.5 per cent dmaged leaves), and low to moderate (5.6 to 5.8 per cent damage and 8.7 to 163 average damage/ 10 hills) at other centers in Andhra Pradesh, Bihar, Tamil Nadu, Orissa, West Bengal and Uttar Pradesh.

The percent damage and larval population maintained a low key during the first two months of, July and August, which ranged between 0.5-6.0 and 0.1-2.8, respectively, except during fourth week of August, the per cent damage and larval population were 12.0 and 2.8, respectively, when the weather factors *viz.,* maximum temperature, minimum temperature, rainfall, relative humidity at morning, relative humidity at evening and sunshine hours were 32.0 ^{0}C, 25.08 ^{0}C, 6.71 mm, 86.37 per cent, 70.0 per cent and 2.08 hrs., respectively. The peak activity was exhibited during the last week of October, when per cent damage and larval population were 44.0 and 10.6, respectively. At this time meteorological parameters *viz.,* maximum temperature, minimum temperature, rainfall, relative humidity at morning, relative humidity at evening and sunshine hours ranged between 25.75 ^{0}C-34.6 ^{0}C, 15.46 ^{0}C-16.07 ^{0}C, 0.0-1.7 mm, 91.5-80.62 per cent, 36.87-52.37 per cent, 5.57-8.66 hrs., respectively. In September, the infestation and larval populations were very much appreciable, and ranged between 5.5 – 28.0 and 1.0 – 8.25, respectively. The weather factors during this period viz., maximum temperature, minimum temperature, rainfall, relative humidity at morning, relative humidity evening and sunshine hours ranged between 29.65-35.66 °C, 21.05-27.08 °C, 0.0-14.0 mm, 63.5-95.5 per cent, 36.25-82.62 per cent and 1.63-10.07 hrs., respectively. The activity of pest suddenly decreased in November, perhaps due to the reason that no more leaves are produced. These results corroborate those of Kushwaha (1988), who observed that the rice cultivar Pakistani Basmati had the infestation starting in the first week of August and lasting upto first week of October, peak infestation was at booting to panicle emergence stage, at Haryana which had similar conditions as existing at Delhi. Such reports had also been obtained by others (Malik *et al.,* 1985, Qudeer *et al.,*1988 and Kushwaha 1995). These reports had mentioned that pest resurgence was noticed due to excess nitrogenous fertilizers and application of granular pesticides. Chander and Singh (1998) while investigating the spatial distribution and the economic enjury level indicated that crop at 70 days after transplanting was vulnerable to attack, and a level of four folded leaves at panicle initiation stage is the economic injury level, beyond which control measures are essential. The present study, concludes that for a sustainable crop yield, it is essential that control measures are undertaken before 70-80 days after transplanting in the Pusa Basmati rice cultivar.

Thus, it may be concluded that the infestation was low at the early and later crop growth stages, and peak the period infestation was at the maximum tillering and booting stages showing strong crop growth stage specificity. These observations are in agreement with the earlier findings of Hirao (1976), and Arida and Shephard (1986); who also reported that variations in the peak period of leaf folder incidence was observed due change in showing dates and growing season of the crop. Patel *et al.*, (1987) reported that long dry spell interspersed with cloudy weather adversely affected the natural enemies of rice leaf folder, promoting its population build-up. According to Dhaliwal *et al.*, (1988), the incidence of *C. medinalis* on late trans planted rice was found to be higher than on early planted crop. They also reported that the planting up to third week of June suppressed the population. Qudeer *et al.*, (1988) found that the peak incidence occurred in mid-September, when the crop was at panicle emergence stage. The variation in the peak period of incidence was certainly the outcome of a complex, biological interacting systems. However, the phenological changes in the host crop in combination with the seasonal changes in agroclimatic conditions seemed to regulate the pest population to a greater extent.

In the early stage, infestation remained a bit probably due to its low initial population as well as the prevalence of less favorable weather conditions, *viz.*, high temperature and low humidity during July. The pest activity reached its peak in later part of October and it was also more or less within narrow range of variation from September and November. It is surmised that this may happen not only due to favourable weather conditions, but also the availability of suitable host could equally play important role in the proliferation and multiplication. This can be corroborated with the sharp decline in the pest infestation in October.

The correlation studies between larval population and percent damage with weather parameters viz., maximum and minimum temperature, rainfall, morning and evening relative humidity and sunshine hours were carried out to find out the influence of weather parameters on larval population and (Table 4). Among the weather parameters, sunshine hours (larval population + 0.379424) and (per cent damage + 0.346180) are highly significant ($p < .001$). While maximum temperature (-0.458814 larval population, -0.555814 percent damage, rainfall (-0.341316 larval population, -0.329902 percent damage) and relative humidity at evening (-0.514448 larval population, -0.538198 per cent damage) have highly negative impact on larval population and percent damage. Relative humidity at morning does not influence the larval population and damaged.

TABLE 4. Correlation between larval population and per cent damaged leaves with weather parameters

WEATHER PARAMETERS	LARVAL POPULATION	DAMAGE (%)
Maximum temperature	-0.458814**	-0.555814**
Minimum temperature	-0.566719**	- 0.614967**
Rainfall	-0.341316**	- 0.329902**
Relative humidity (morn.)	-0.054182	-0.061583
Relative humidity (even.)	-0.514448**	-0.538198**
Sunshine hours	+0.379424**	+0.346180**

[(* *) indicate significance at 1 per cent level of significance and (*) indicate significant at 5 per cent level of significance.]

The correlation between larval population and per cent damaged leaves is very high (0.965927), showing that both the larval population and per cent damage are influencing each other. The weather parameters namely, low temperature, low rainfall, and low relative humidity are favourable for larval population buildup, as well as damage, while long days (sunshine hours) are responsible only for larval population buildup and high infestation. According to Kumar *et al.,* (1996), weather factors *viz.,* maximum and minimum temperature, rainfall and relative humidity had no definite role on the population dynamics, amongst the biotic factors, none showed pronounced effect in regulating the pest population. It was probaby due to the narrow range in variation of maximum temperature during crop season; however, the other parameters varied widely but did not show significant role on the incidence. Further. Ram (1986) observed that the early and heavy monsoon followed by a long dry spell and humid weather induced pest outbreak. Thus the higher infestation in September and October may be due to of low rainfall in the preceding month of August and September.

■ Regression between per cent damage and larval population

The relationship was also quantified by using simple regression and results are given below.

per cent damaged leaves]= 1.054672* + 3.711517** (larval population)

(0.477321) (0.126299)

R^2=0.933015, P< .0.01

[Figures in parenthesis are standard error and * * indicate significance at 1 per cent level of significance and * indicate significant at 5 per cent level of significance.]

In both the intercept term and regression coefficient, the larval population is highly significant. This relationship can also be used to quantify the per cent damage based on larval population/count. The relationship could be useful in rice growth models as the effect of leaf folder larval population.

■ Regression between per cent damage and weather parameters

The effect of various weather parameters on damage were carried out by using step-wise multiple regression procedure. It yielded the following equation.

Per cent damage]= 64.09876** -1.0.0675* × max. temp. –0.86788** × min. temp.

(12.94) (0.4856) (0.255)

$\mathbf{R^2}$ = 0.419 P< 0.0.01

[Figures in parenthesis are standard error and * * indicate significance at 1 per cent level of significance and * indicate significant at 5 per cent level of significance.]

In the step-wise regression model, only maximum and minimum temperature were included. All the terms are significant either at 1% (intercept, min. tepreture) or at 5% (max. tempreture). The R^2 of the model aws 0.419. This model may be used to predict the damage by using the weather factors.

■ **Regression between larval population and weather parameters**

The effect of various weather parameters on larval population were carried out using step-wise multiple regression procedure. It yielded following equation-

Larval population]= 13.13702** -0.14991 × max. temp. –0.23967 × min.temp.

(3.606554) (0.135264) (0.071069)

$\mathbf{R^2} = 0.334569$ P< 0.0.01

[Figures in parenthesis are standard error and * * indicate significance at 1per cent level of significance and * indicate significant at 5per cent level of significance.]

In the step-wise regression model, only maximum and minimum temperature were included. However, the t-test for regression cofficients are not significant for both minimum and maximum temperature. But the intercept was highly significant. The model may be used to predict the larval population based on temperature. The R^2 is low here, and hence the model may not be stable. Further studies with more number of years are required to build a more stable prediction model.

STUDIES ON LARVAL AND PUPAL PARASITIZATION IN RELATION TO WEATHER PARAMETERS

Studies on the effect of weather factors on larval and pupal parasitization of leaf folder, *Cnaphalocrocis medinalis* (Guenee) at Delhi during cropping season, over four years revealed that these were ranged between 7.25-33.5 per cent and 10-50 per cent, respectively. The weather factors *viz.,* minimum and maximum temperature, rainfall, morning and evening relative humidity, and sunshine hours at this period ranged between, (21.65-36. 62 ^{0} C and 7.72-31.75^0 C), 0.0- 22.14 mm, 63.5- 92.37 per cent and 23.25-82.62 per cent; and 1.49-10.07 hrs., respectively. The peak parasitization was observed during third and fourth week of September, which ranged between 24.5-33.5 per cent larvae and 10.0-50.0 per cent pupae at about 60-85 days after transplanting. Arida and Shepard (1990) reported the larval and pupal parasitization is on an average 40 per cent in the farmers field, while Kabayashi and Wada (1979) recorded, 11.0 per cent of pupal and 34.0 to 50.0 per cent of larval parasitization. The lowest parasitizations were recorded during the month of July followed by August (20-50 days after transplanting) and it were ranged between 7.25-15.25 per cent and 10.0-26.2 per cent, respectively. The weather parameters *viz.*, minimum and maximum temperature, rainfall, morning and evening relative humidity, and sunshine hours at this time were ranged between, 26.8-37.03^0 C and 22.85-31.75^0 C; 0.0-22.14 mm, 67.12- 91.50 per cent and 49.75- 82.0.0 per cent; and 1.49-9.08 hrs., respectively. Abraham *et al.*,(1973) and Joshi *et al.*, (1987) observed 7.4 per cent pupae; Rajpakse, (1990) reported 5.6 per cent and 4.0 per cent parasitization of larvae and pupae, respectively, and these findings corroborate the results of the present study.

The larval and pupal parasitization in 1997 ranged between 8.2-33.5 per cent and 10.0-50.0 per cent, respectively (Table 14). The meteorological parameters *viz.*, minimum and maximum temperature, rainfall, morning and evening relative humidity, and sunshine hours at this time were ranged between 21.65-35.68^0 C and 1.21-27.31^0 C, 0.0-13.05 mm, 63.5- 92.37 per cent and 31.85- 71.26 per cent; and 1.57-10.07 hrs., respectively. The peak activity of parasitoids was recorded during third week of September, (*i.e.*, 8.2-33.5 per cent larval and 10-50 per cent pupal parasitization) followed by second and fourth week. The lowest parasitization of larvae and pupae was during July to mid August, is varied between 8.2-9.55 per cent and 10.0-14.5 per cent, respectively. The meteorological parameters at the peak parasitization, *viz.*, minimum and maximum temperature, rainfall, morning and evening relative humidity, and sunshine hours were 34.87 and 24.74^0 C; 0.0 mm, 76.71-54.42 per cent; and 7.48 hrs., respectively, (Fig.334). The larval parasitization under natural conditions at 40 and 50 days after transplanting was 10.0 and 11.3 per cent, respectively (Anonymous, 1999) which agree with the present findings.

Data of 1998, data shows (Table 15), that the larval and pupal parasitization varied between 7.25-28.2 per cent and 12.0-38.0 per cent, respectively, when the meterological factors *viz.*, minimum and maximum temperature, rainfall, morning and evening relative humidity, and sunshine hours ranged between 26.66- 36.62^0 C and 7.72- 31.75^{0}C; 0.0-12.85 mm, 67.12-91.37 per cent and 23.25-82.62 per cent and 1.49-8.66 hrs., respectively. The peak parasitization was observed during the September, when the larval and pupal parasitization was ranged between 18.75-28.2 per cent and 25.0-38.0 per cent, respectively. The weather factors *viz.*, minimum and maximum temperature, rainfall, morning and evening relative humidity, and sunshine hours at this period ranged between 29.65-35.34^0 C and 25.31-27.01^0 C; 0.0-14.0 mm, 85.42-95.5 per cent and 61.28-82.62 per cent and 4.30-6.25 hrs., respectively. While the lowest parasitization was recorded during early stage of crop, in the months of July and August, when the larval and pupal parasitization ranged between 7.25-12.35 per cent and 12.0-18.5 per cent , respectively, and during this period, weather parameters *viz.*, minimum and maximum temperature, rainfall, morning and evening relative humidity, and sunshine hours ranged between 32.1-36.62^0 C and 22.85-31.75^0 C; 0.75- 12.85 mm, 67.12-89.87 per cent and 57.37-79.0 per cent; and 1.49-7.13 hrs., respectively (Fig.335). In October and November the larval and pupal parasitization ranged between 13.0-20.0 per cent and 18.5- 26.2 per cent, respectively; the weather factors *viz.*, minimum and maximum temperature, rainfall, morning and evening relative humidity, and sunshine hours at this time ranged between 26.66-34.5^0 C and 11.27- 26.02^0 C; 0.0- 22.14 mm, 83.42- 91.37 per cent and 23.25-73.87 per cent; 1.72-8.66 hrs., respectively. The larval parasitization reported by Pati and Mathur, (1982) was 34.0-54.0 per cent, while Chatterjee, (1987), reported that the larval parasitism of *C. medinalis* was 21.7 per cent. These findings are in concordance of the present study.

The data shows (Table 16), that the per cent parasitization during the crop season of 1999, ranged between 10.5-25.0 per cent and 18.0-42.0 per cent, respectively; and the weather factors *viz.*, minimum and maximum temperature, rainfall, morning and evening relative humidity, and sunshine hours ranged between 26.83-35.41^0 C and 9.35-2888^0 C; 0.0-22.14 mm, 72.62- 91.5 per cent and 25.57-82.0 per cent; 1.72-9.08 hrs., respectively. The high larval and pupal parasitization (*i.e.*,18.5-25.0 per cent and 33.5-42.0 per cent, respectively) was in the month of September and during this period the weather parameters *viz.*, minimum and maximum temperature, rainfall, morning and evening relative humidity, and sunshine hours ranged between 31.98-34.98^0 C and 24.71-25.06^0 C; 0.0-7.92 mm, 86.62-91.42 per cent and 67.0-76.0 per cent; 3.46-7.47 hrs., respectively. The lowest parasitization ranged between 10.5-15.25 per cent larvae and 18.0-25.75 per cent pupae, during mid July to August, when the meteorological parameters *viz.,* minimum and maximum temperature, rainfall, morning and evening relative humidity, and sunshine hours ranged between 32.35-36.4^0 C and 26.02-28.88^0 C; 0.0-22.14 mm, 72.62-91.5 per cent and 49.75-82.0 per cent and 1.72-9.08 hrs., respectively (Fig. 336). In October and November, the parasitization of larvae and pupae varied (*i.e.,* 12.5-20.8 per cent and 19.5-26.0 per cent, respectively), and the weather factors *viz.,* minimum and maximum temperature, rainfall, morning and evening relative humidity, and sunshine hours at this period ranged between 26.83-33.73^0 C and 9.35-22.42^0 C; 0.0-4.0 mm, 80.62-90.37 per cent and 25.57-76.25 per cent and 5.35-8.0 hrs., respectively. These findings agree with those of Manisegaran *et al.,* (1997).

The larval and pupal parasitization ranged between 7.5-28.5 per cent and 10.0-42.5 per cent, respectively, during crop season of 2000, (Table 17); and the meteorological parameters, *viz.,* minimum and maximum temperature, rainfall, morning and evening relative humidity, and sunshine hours at this time ranged between 25.3-3523^0 C and 10.48-27.17^0 C, 0.0- 21.4 mm, 69.28- 91.87 per cent and 31.88-79.12 per cent, and 1.63-8.32 hrs., respectively. The peak parasitization observed during September was 28.5 per cent and 42.5 per cent, respectively and the meteorological parameters *viz.,* minimum and maximum temperature, rainfall, morning and evening relative humidity, and sunshine hours at this period 33.57^0 C and 21.05^0 C; 0.23 mm, 79.0 per cent and 54.62 per cent and 8.14 hrs., respectively. The lowest parasitization was observed (9.5-14.75 per cent larvae and 11.25-16.75 per cent pupae), and during this period the weather factors *viz.,* minimum and maximum temperature, rainfall, morning and evening relative humidity, and sunshine hours ranged between 31.72-37.07^0 C and 25.32-27.17 ^{0} C; 0.71- 21.4 mm, 69.28-91.87 per cent and 62.12-79.12 per cent; and 2.65-6.03 hrs., respectively. In October and November, the was very much considerable, and ranged between 7.5-20.2 per cent and 17.0-33.75 per cent, respectively; the meteorological parameters *viz.,* minimum and maximum temperature, rainfall, morning and evening relative humidity, and sunshine hours at this time ranged between 25.3-35.23^0 C and 10.48-21.67^0 C; 0.0 mm, 74.62-89.63 per cent and 31.88-59.43 per cent; and 4.0-8.32 hrs., respctively (Fig. 337). These findings are similar to the observations of Hu and Wu (1987) and Tian (1987), who reported, 28.6 per cent larval parasitism of *C. medinalis,* while Rao *et al.*,(1969) who recorded 45 per cent larval parasitization which is high in comparison to the of present findings.

The results of the correlation studies between larval and pupal parasitization in relation to weather factors, *viz.,* minimum and maximum temperature, rainfall, morning and evening relative humidity, and sunshine hours are given in Table 5. The sunshine hours were found to have a (+0.411626 larvae and +0.361075 pupae) are highly significant (P< 0.01), the rainfall (-0.264729 pupae) had negative impact on parasitization. However, the rainfall (-0.183981 larvae) and maximum temperature (-0.183324 pupae) had some significant effect on parasitization with both getting relatively correlated.

TABLE 5. Correlation between larval and pupal parasitization with weather parameters

WEATHER PARAMETERS	LARVAL PARASITIZATION	PUPAL PARASITIZATION
Maximum temperature	+0.042458	-0.183324*
Minimum temperature	+0.054782	- 0.150706
Rainfall	-0.183981*	- 0.264729**
Relative humidity (morn.)	-0.050639	-0.026224
Relative humidity (even.)	-0.044258	-0.133716
Sunshine hours	+0.411626**	+0.361075**

[(* *) indicate significance at 1 per cent level of significance and (*) indicate significant at 5 per cent level of significance].

The correlation between larval and pupal parasitization is very high (0.813990), showed that either one of them is enough to monitor the parasitoids activity in field condition.

This shows that if larval parasitization are high then we can expect pupal parasitization to be high. The relationship was also quantified by using simple regression and results are given below-

■ **Regression between larval and pupal parasitism**

Pupal parasitization]= 4.157587* + 1.245931** (Larval parasitization)

(1.887585) (0.106269)

R^2= 0.662580, P< 0.0.01

[Figures in parenthesis are standerd error and * * indicate significance at 1 per cent level of significance and * indicate significant at 5 per cent level of significance.]

In both the intercept term and regression cofficient, the larval parasitization is highly significant, while in case of pupal parasitization, it is significant only at 5 per cent level of significance.

CHAPTER-8

SUMMARY

SUMMARY

The present study carried out by the author on the "Biosystematic studies of family Pyralidae associated with rice crop in India" are presented in this thesis. In addition, studies were also conducted on the bionomics, population dynamics and natural parasitization of larvae and pupae of leaf folder, *Cnaphalocrocis medinalis* (Guenee) on Pusa Basmati rice cultivar under Delhi conditions.

The first chapter introduces the subject matter. This includes area, production and losses of rice crop due to insect pests especially of family Pyralidae. Economic importance, salient features and the necessity to carry out further work is highlighted.

The review of literature on the taxonomy and nomenclature of family Pyralidae and biology and ecology of leaf folder, *Cnaphalocrocis medinalis* (Guenee) constitute the second chapter. In this chapter chronological accounts of the work done by various workers are given. It is divided into three parts. In the first part, the nomenclature of the family and its division into different subfamilies are discussed, whereas the second part deals with the taxonomy of various genera and species. The third part deals with the work done on biology and ecology of leaf folder.

The source of the materials and the methods employed in connection with these studies are dealt with in the third chapter. Herein, procedure adopted by the author for the collection, mounting and preparation of the material for their final microscopic examinations and detailed studies are given. Tabulation of data for studying the correlation and regression of population buildup with weather parameters and techniques adopted for study of biology forms the subject matter of this chapter.

The fourth chapter comprises of a general morphology of the family Pyralidae to acquaint with the various terminology used in the descriptions, laying more stress on those of taxonomic importance, illustrating the same with suitable diagrams.

The fifth chapter is devoted to the classification and taxonomic studies of 25 species belonging to 16 genera under 5 subfamilies. Keys to all the examined subfamilies, genera and species are given, which are followed by their diagnostic characters including external features, neurations of fore and hind wings, male and female genitalia, length, wing span, distribution, and material examined for each species. The wing venation, legs, genitalia of male and female, of all the species are illustrated. Coloured photographs of male and female adults of all the 25 species (except *Scirpophaga fusciflua,* only female) and their enlarged head showing labial palpi and eyes are given.

A taxonomic discussion on the various taxa used in the thesis are presented in the sixth chapter. Some suggestions regarding nomenclature and characterization of few species have also been included for the sake of future workers.

In the seventh chapter on the biology and effect of weather factors (maximum and minimum temperature, rainfall, relative humidity at morning, relative humidity at evening and sunshine hours) on the population buildup of rice leaf folder, *C. medinalis* (Guenee) through light trap and net collection under the agroclimatic conditions of Delhi are given.

A female laid 68-94 eggs (average 80.9 eggs) in its life time. Incubation period was 7-9 days (average 6 days), larval period 19-27 days (average 23 days), pupal period 6-8 days (average 7.8 days), adults live, male 2.0-4.0 days (average 3 days) and female 6.0- 9.0 days (average 7.5 days). The total life cycle occupied, male 33.0-48.0 days (average 40.5 days) and female 37.0-53.0 days (average 45.0 days).

The higher moth numbers were trapped in the month of October, exhibiting the peak activity in the first week, followed by September, while the trap catches begun in the first week of June, when the crop was in nursery stage, during this time the trapped moths numbers were very low.

The correlation studies between light trap and net sweep collection with weather parameters on population buildup were carried out. Among the weather parameters, maximum temperature minimum temperature and relative humidity at morning are highly significant ($P < 0.01$). Maximum temperature and minimum temperature have negative impact on the population buildup. However the relative humidity at morning has a positive impact. Thus the low temperature and high relative humidity at morning are favorable for population buildup. The correlation between net sweep collection and light trap collection is very high (0.866), showing that either one of them is enough to monitor the leaf folder population in the field conditions. Both the intercept term and the regression cofficient are highly significant. Thus this can be used as a formula to estimate light trap collection based on the net sweep collection or vice-versa. The dry period and longer sunshine hours, and light rains with two or three cloudy days, and sudden drop in the day and night temperature appear to trigger their peak activity, during October to November.

The studies on the per cent damaged leaves and larval population in relation to weather factors and stage of crop for four years (1997-2000) revealed that the per cent damaged leaves and larval population ranged between 0.5-44.0 and 0.1-10.6, respectively. The per cent damaged leaves and larval population maintained a low key during first two months, July and August, which ranged between 0.5-6.0 and 0.1-2.8, respectively, except during fourth week of August, the per cent damaged leaves and larval population were 12.0 and 2.8, respectively. The peak activity was exhibited during the last week of October, when per cent damaged and larval population were 44.0 and 10.6, respectively.

The correlation studies between larval population and per cent damage, with weather parameters were shows that, the sunshine hours (larval population + 0.379424) and (per cent damage + 0.346180) are highly significant ($p < .001$). While maximum temperature (-0.458814 larval population, -0.555814per cent damaged leaves, rainfall (-0.341316 larval population, -0.329902per cent damage) and relative humidity at evening (-0.514448 larval population, -0.538198 per cent damage) have highly negative impact on larval population and per cent damage, whereas relative humidity at morning is not influencing the larval population and per cent damage.

The correlation between larval population and per cent damage is very high (0.965927). This shows that both (larval population and per cent damage) are influencing each other. Whereas in case of weather parameters, low temperature, low rain fall and low relative humidity are favorable for high larval population buildup as well as high per cent damage, while long day (sunshine hours) are responsible for larval population buildup and high infestation. In both the intercept term and regression coefficient, the larval population is highly significant. This relationship can also be used to quantify the per cent damage leaves, based on larval population. The relationship could be useful in rice growth models as the effect of leaf folder larval population. In the step-wise regression model, only maximum and minimum temperature were included. However. the t-test for regression coefficients are not significant for both minimum and maximum temperature. The intercept was highly significant. The model may be used to predict the larval population based on temperature. The R^2 is low, hence the model may not be stable. Further studies with more number of years are required to build a more stable prediction model.

Studies on the effect of weather factors on the larval and pupal parasitization of leaf folder, *Cnaphalocrocis medinalis* (Guenee), revealed these ranged between 7.25-33.5 per cent and 10-50 per cent, respectively. The peak parasitization was observed during third and fourth week of September, and ranged between 24.5-33.5 per cent larvae and 10.0-50.0 per cent pupae. at about 60-85 days after transplanting. The correlation studies between larval and pupal parasitization, in relation to weather factors, among the weather factors, sunshine hours (+0.411626 larvae and +0.361075 pupae) are highly significant ($P< 0.01$). The rainfall (-0.264729 pupae) have negative impact on parasitization. However, the rainfall (-0.183981 larvae) and maximum temperature (-0.183324 pupae) are also significant at 5 per cent level of significance. The correlation between larval and pupal parasitization is very high (0.813990). This showed that either one of them is enough to monitor the parasitoids activity in field conditions. In both the intercept term and regression coefficient, the larval parasitization is highly significant. while in case of pupal parasitization, it is significant at 5 per cent level of significance.

In the last chapter all the 322 references (with complete title, name of journal, volume and page number etc.) mentioned in the text is given.

Two appendixes append the thesis. The first one is a checklist of genera and species examined and second one is with all the informations about types (including type localities, sex and number of type specimens and type location with certain remarks) of valid species and their synonymies.

Finally the thesis contained 27 plates with 337 figures and 12 tables.

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APPENDIX-I

APPENDIX- I

CHECK-LIST OF PYRALID ASSOCIATED WITH RICE IN INDIA

1. *Ancylolomia* Huebner 1825: 363
    - *Ctenus* Mabille 1906: 32
    - *Jartheza* Walker 1863[a]: 183
    - *Pseudoctenella* Strand 1907 : 175
        - *chrysographella* (Kollar) 1848 : 494
            - *argentata* Moore 1884-87 : 382
            - *capensis* Zeller 1863 : 11
            - *indica* Felder & Rogenhoeffer 1874 : 137
            - *japonica* Zeller 1877 : 24
            - *sansibarica* Zeller 1877: 23
            - *taprobanesis* Zeller 1877 : 25
2. *Borer* Guenee 1862 : 68
    - *sacchariphagus indicus* (Kapur) 1950 : 414
3. *Bradina* Lederer 1863 : 424
    - *Erilita* Lederer 1863: 426
    - *Pleonectusa* Lederer 1863 : 426
    - *Trematarcha* Meyrick 1886 : 233
        - a*dmixtalis* (Walker) 1859[b]: 665
            - *leptogastralis* Walker 1865: 1432
            - *pallidalis* Warren 1896 : 147
            - *panaeusalis* Walker 1859[c]: 998
            - *tabidalis* Lederer 1863 : 426
            - *avunculalis* Saalmueller 1880: 297
            - *sodalis* Lederer 1863 : 481

4. *Chilo* Zincken 1817 : 23

    Diatraenopsis Dyar & Heinrich 1927 : 39

    Diphryx Grote 1882 : 273

    Hypiesta Hampson 1919[b] : 538

    Nephalia Turner 1911 : 113

    Silveria Dyar 1925 : 10

        partellus (Swinhoe) 1885: 879

            lutulentalis Tams 1932: 127

            zonellus Swinhoe 1884 : 528

        suppressalis (Walker) 1863[a]: 166

            orizae Rebel 1940 : 116

            oryzae Flethcher 1928 : 59

            simplex Butler 1877[a] : 400

5. *Chilotrea* Kapur 1950 : 402

        auricilus (Dudgeon) 1905 : 405

            popescugorji Bleszynski 1963 : 179

        infuscatellus (Snellen) 1890[b] : 94

            calamina Hampson 1919[b] : 554

            coniorta Hampson 1919[b] : 449

            shariinensis Eguchi 1933: 3

            tadzhikiellus Gerasimor 1949 : 704

            sticticraspis Hampson 1919[b]: 449

        polychrysus (Meyrick) 1932: 321

6. *Cnaphalocrocis* Lederer 1863 : 384

    Dolichosticha Meyrick 1884 : 304

    Epimima Meyrick 1886 : 235

    Lasiacme Warren 1896[b] : 176

    Marasmia Lederer 1863 : 385

    Bradinomorpha Matsumura 1920: 514

    Neomarasima Kalra, David and Banerjee 1966: 554

    Prodotaula Meyrick 1934 : 15

Susumia Marumo 1930: 41

bilinealis (Hampson) 1891: 139

medinalis Guenee 1854 : 201

nurscialis Walker 1859[b]: 724

patnalis (Bradley) 1981 : 323

poeyalis (Boisduval) 1833 : 33

hampsoni Rothschild 1921

venilalis Walker 1859[a] : 373

cicatricosa Lederer 1863 : 386

marisalis Walker 1859[b]: 717

rectistrigosa Snellen 1872 : 15

minutalis Mabille 1880 : 25

suspicalis (Walker) 1859[b]: 667

bifurcalis Snellen 1880[a]: 219

convectalis Walker 1865 : 1411

creonalis Walker 1859[b]: 579

neoclesalis Walker 1859[b] :635

trapezalis ; auctt.

7. *Crypsiptya* Meyrick 1894[b] : 463

Coclebotys Munroe & Mutuura 1969 : 862

coclesalis (Walker) 1859[b] : 701

interfusalis Walker 1865 : 1443

itemalesalis Walker 1859[c] : 996

lacrymalis Leech 1889 : 69

strenualis Walker 1865 : 1409

8. *Herpetogramma* Lederer 1863 : 430

Pachyzancla Meyrick 1884 : 315

Acharana Moore 1884-87 : 285

Piloptila Swinhoe 1894 : 142

Pantoecome Warren 1896[b] : 173

Ptiloptila Hampson 1899 : 291

Macrobotys Munroe 1950: 228

licarsisalis (Walker) 1859[b] :686

fumidalis Walker 1865 : 1486

phraxalis Walker 1859[b] : 725

serotinalis Joannis 1888: 272

immundalis Walker 1865 : 1448

phoeopteralis (Guenee) 1854: 349

abstrusalis Walker 1859[b]: 663

otreusalis Walker 1859[b]: 637

triarialis Walker 1859[b]: 639

vestalis Walker 1859[b]: 579

9. *Mabra* Moore 1884-87: 280

Streptabela Turner 1937: 61

eryxalis (Walker) 1859[b]: 371

velatalis Snellen 1880[b]: 63

10. *Maliarpha* Ragonot 1888 : 48

separatella Ragonot 1888: 48

pallidicosta Hampson 1896 : 57

vectiferella Ragonot 1901 : 391

11. *Notarcha* Meyrick 1884 : 310

Haritala Moore 1884-87 : 311

obrinusalis (Walker) 1859[b]: 549

graphicalis Swinhoe 1886 : 459

nigripunctalis Fawcett 1916 : 736

trigalis Lederer 1863 : 375

12. *Parapoynx* Huebner 1825: 26

Paraponyx Guenee 1854 : 274

Eustales Clemens 1860 : 216

Seronia Clemens 1860 :

Nymphaeela Grote 1880 : 97

Hydreretis Meyrick 1885 : 435

Microdracon Warren 1890

Cosmophylla Turner 1908 : 85

flustuosalis (Zeller) 1852 : 27

chrysippusalis Walker 1859[a] : 432

curta Butler 1879[a] : 270

linealis Guenee 1854 : 271

luteivittalis Mabille 1880 : 29

obitalis Walker 1859[a] : 432

oryzalis Wood-Mason 1885, C & S No. 4400

stagnalis (Zeller) 1852 : 26

hilli Tepper 1890 : 60

decussalis Walker 1859[a]: 481

depunctalis Guenee 1854 : 274

vestigialis Snellen 1890[a]: 628

13. *Pleuroptya* Meyrick 1890 : 443

Loxoscia Warren 1890 : 476

balteata (Fabricius) 1798 : 457

accipitralis Walker 1865 : 1422

aurantiacalis Fischer v. Rosterstamm 1840 : 213

aurea Butler 1879[b] : 74

crocealis Duponchel 1831 : 365

evergestialis Strand 1918[a] : 51

fraterna Moore 1884-87 : 338

14. *Saluria* Ragonot 1887 : 258

Atascosa Hulst 1890 : 210

Baroda Ragonot 1888: 42

Cayuga Hulst 1888 : 116

Eumoorea Dyar 1917 : 91

Goya Ragonot 1888 : 43

Ollia Dyar 1904 : 107

Paramatta Hampson 1901 : 366

Pectinigeria Ragonot 1888: 43

Poujadia Ragonot 1888 : 42

inficita (Walker) 1863[a] : 30

15. *Schoenobius* Duponchel 1836 : 8

Catagela Walker 1863[a]: 191

Microchoenia Meyrick 1887[b]: 270

Panalipsa Moore 1884-87: 386

immeritalis Walker 1859[c]: 830

decursella Walker 1863[a]: 194

16. *Scirpophaga* Treitschke 1832 : 55

Apurima Walker 1863[a]: 194

Tryporyza Common 1960 : 339

fusciflua Hampson 1893 : 167

gilviberbis Zeller 1863 : 2

incertulas (Walker) 1863[a]: 143

adnotalis Walker 1863[a] : 192

bipunctifera Walker 1863[b]: 523

gratiosellus Walker 1864 : 967

minutellus Zeller 1863 : 5

punctellus Zeller 1863: 4

bipunctifer ab. *quadripunctellus* Strand 1918[b] : 263

nivella (Fabricius) 1794 : 296

auriflua Zeller 1863 : 2

brunnescens Moore 1888: 225

celidias Meyrick 1894[b]: 475

euctastalis Strand 1918[b] : 262

chrysorrohoea Zeller 1863 : 1

APPENDIX-II

APPENDIX- II

DETAILS OF TYPE LOCALITIES, SEX, NUMBERS AND LOCATIONS OF PYRALID PESTS ASSOCIATED WITH RICE CROP IN INDIA

Name of valid species and their synonyms	Type locality	Sex of types		No. of type specimens	Type location	Remarks
		Male	Female			
Ancylolomia chrysographella (Kollar)	Masur (Himalaya)					
Ancylolonmia argentata Moore	Sri Lanka	+	+		BMNH	
Ancylolomia capensis Zeller						
Ancylolomia indica Felder & Rogenhoeffer	Calcutta					
Ancylolomia japonica Zeller						
Ancylolomia sansibarica Zeller						
Ancylolomia taprobanensis Zeller	Bombay				BMNH	
Borer sacchariphagus indicus (Kapur)	Pusa (Bihar),Coimbatore ,Sibsagar (Assam)	+	+	15	BMNH and IMC	Holotype male in BMNH 6 male and female Paratypes in BMNH; 8 male and female Paratypes in IMC.
Bradina admixtalis Walker	Sri Lanka	+	+	3	BMNH	
Spoladea avuncualis Soalmueller						
Botys leptogastralis Walker	New Guinea	+	-	-	UMO	Walker recorded the type specimen from New Guiea but the specimen has a label of Ceram
Botys pallidalis Warren	Khasi	+	-	1	BMNH	Holotype
Botys panaeusalis Walker	Sri Lanka	+	-	1	BMNH	Holotype
Pleonectusa sodalis Lederer	Amboina	+	-	2	BMNH	
Pleonectusa tabidalis Lederer	Amboina	-	-	4	BMNH	
Chilo partellus (Swinhoe)	Bombay, Poona	+	-	13	BMNH	Lectotype male, 12 Paralectotype males
Argyria lutulentalis Tams	Nyasaland	-	+	1	BMNH	Holotype female
Crambus zonellus Swinhoe	Karachi	+	-		BMNH	Lectotype male
Chilo suppressalis (Walker)	Sanghai (China)	-	+	1	BMNH	Holotype female
Chilo simplex Butler	Taiwan	+	-	2	BMNH	Lectotype, Paralectotype male

Chilo orizae Rebel						Mis-spelling
Chilo oryzae Fletcher	Pusa (Bihar)	-	+	1	BMNH	Holotype female
Chilotraea auricilia (Dudgeon)	Burogah (N. Bihar),Bhutan, Sikkim	+	+	16	BMNH	1 holotype male
Chilo popescugorji Bleszynski	Taiwan	-	+	5	GAMB	Holotype female, 4 Paratypes females
Chilotraea infuscatellus (Snellen)	Java	+	-	-	MNHL	1 Lectotype male
Diatraea calamina Hampson	Kinuya, Myanmar	-	+	5	BMNH	Three syntypes from Kanpur, Mugal Sarai and Pusa belonging to *Chilo partellus* (Swinhoe). Lectotype male, 4 paralectotypes male
Argyria coniorta Hampson	Pusa (Bihar)	+	-	2	BMNH	Lectotype male, 1 Paralectotype male
Diatraea shariinensis Eguchi	Korea	-	+	3	BMNH	Lectotype female, 2 Paralectotypes female
Argyria sticticraspis Hampson	Coimbatore	-	+	1	BMNH	Holotype female
Chilo tadzhikiellus Gerasimov	Tadzkistan	+	+	2	ZIL	1 Lectotype male, 1 Paralectotype female
Chilotraea polychrysa (Meyrick)	Malay penisula, Perak, Selanger, Alor Star, Kuan, Sungei Tera, Parit, Buntar, Malaysia, Titiserong, Pekon Kepar	+	+	16	BMNH	1 Lectotype male, 15 Paralectotypes males and females
Cnaphalocrocis bilinealis (Hampson)	Sarawak , Malaysia	+	+		BMNH	
Dolichosticha subauralis Warren	Khasi	-	-	Several	BMNH	
Cnaphalocouis medinalis (Guenee)	Indes Orientales	-	+	1	ICG	Holotype female
Botys nurscialis Walker	Moreton Bay, Sydney	+	-	4	BMNH	Three males from Moreton Bay, 1 male from Sydney
Cnaphalocrocis patnalis (Bradley)	Brunei, Sri Lanka	+	+	52	BMNH	
Cnaphalocrocis suspicalis (Walker)	Sri Lanka	-	+	1	BMNH	Holotype female
Cnaphalocrocis bifurcalis Snellen	Celebes	-	-	-	ISC	
Botys convectalis Walker	South India	+	-	1	BMNH	Holotype male

Cnaphalocrocis trapezalis; auctt.						
Cnaphalocrocis poeyalis (Boisduval)						
Asopia venilialis Walker	Moreton Bay	-	-	1	BMNH	
Marasmia cicatricosa Lederer	Java	+	-	1	BMNH	Holotype male
Botys marisalis Walker	Sarawak (Borneo), Sydney	+	+	2	BMNH	
Marasmia ruralis Meyrick	Celebes, Fiji, Java	-	-	Several	BMNH	
Botys minutalis Mabille	Mauritius, Sri Lanka					
Marasmia hampsoni Rothschild	Jigawa (N. Nigeria)	+	-	1	BMNH	Holotype male
Marasmia rectistrigosa Snellen						
Crypsiptya coclesalis (Walker)	Sarawak (Borneo)	+	-	2	UMO	
Botys interfusalis Walker	Java	+	-	3	BMNH	
Botys itemalesalis Walker	Shanghai, China	-	+	1	BMNH	Holotype female
Botys lacrymalis Leech	Japan					
Botys strenualis Walker	S.India	-	+	1	BMNH	Holotype female
Herpetogramma licarsisalis Walker	Sarawak (Borneo)	+	-	1	UMO	Holotype male
Entephria fumidalis Walker	New Guinea	+	-	1	UMO	Holotype male
Botys pharaxalis Walker	Moreton Bay, Sydney	-	+	3	BMNH	
Botys tridentalis Snellen	Java	-	-	-	ISC	
Botys immundalis Walker	Java		+	1	BMNH	Holotype female
Botys serotinalis Joannis						
Herpetogramma phoeopteralis (Guenee)	America	+	+	15	ICG	
Botys abstrusalis Walker	Congo	-	+	1	BMNH	Holotype female
Botys otreusalis Walker	China, Shanghai, Sri Lanka	+	+	13	BMNH	
Botys triarialis Walker	Sierra Leon	+	-	1	BMNH	Holotype male
Botys vestalis Walker	Jamaica	+	+	2	BMNH	
Notarcha obrinusalis Walker	Punjab	-	+	1	BMNH	Holotype female
Zebronia graphicalis Swinhoe	Mhow (India)	-	-	-	BMNH	
Pionea nigripunctalis Fawcett	Masongaleni	+	-	1	BMNH	Holotype male
Botys trigalis Lederer						
Mabra eryxalis Walker	Sri Lanka	+	-	1	BMNH	Holotype male
Botys velatalis Snellen						
Maliarpha separatella Ragonot	Cameroon	+	-	-	ZMB	
Anerastia pallidicosta Hampson	India (Punjab,	+	+	-	BMNH	

	Assam, Nagaland), Myanmar, China, Sri Lanka					
Enosima vectiferella Ragonot	Madagascar	+	-	-	MHNP	
Parapoynx fluctuosalis (Zeller)	Natal, South Africa	-	-	-	BMNH	
Oligostigma chrysippusalis Walker	China	+	-	2	BMNH	
Oligostigma curta Butler	Hawaiian Island	-	-	-	BMNH	
Paraponyx linealis Guenee	Indes Orientales	-	-	-	ICG	
Nymphula luteivittalis Mabille						
Oligostigma obitalis Walker	Australia, Sri Lanka	+	+	8	BMNH	
Parapoynx oryzalis Wood-Mason						
*Parapoynx stagnalis (*Zeller)	Nepal	-	-		BMNH	
*Zebronia decussalis*Walker	Sri Lanka	+	+	3	BMNH	
Hydrocampa depunctalis Guenee	Indes Orientales	+	-	1	ICG	Holotype male
Gonocausta vestigialis Snellen	Sikkim	+	-	3	BMNH	
Hydrocampa hilli Tepper	Australia	-	-	-	-	
Pleuroptya balteata (Fabricius)	Ostindien	-	-	-	-	
Botys accipitralis Walker	Ceram	+	-	-	UMO	Actually type specimen is male not female as mentioned in the next.
Botys aurantiacalis Fischer v.Rostersman	-	-	-	-	-	
Botys aurea Butler	Yokohama (Japan)	-	-	-	BMNH	
Botys crocealis Duponchel						
Sylepta evergestalis Strand						
Hapalia fraterna Moore	Sri Lanka	-	-	-	BMNH	
*Saluria inficita (*Walker)	Sri Lanka	+	+	2	BMNH	
Schoenobius immeritatis Walker	Sri Lanka	+	-	1	BMNH	Holotype male
Araxes decursella Walker	Not known	+	+	-	BMNH	
Scirpophaga fusciflua Hampson	Pundaloya (Sri Lanka)	+	-	1	BMNH	Holotype male
Scirpophaga gilviberis Zeller	Calcutta	-	+	1	BMNH	Holotype female
Scirpophaga incertulas (Walker)	Sarawak (Borneo)	+	-	1	BMNH	Holotype male
Catagela adnotalis Walker	Colombo (Sri Lanka)	+	-	1	BMNH	Holotype male
Tipanea bipunctifera Walker	Borneo	-	+	1	BMNH	Holotype female Walker wrongly mentioned

						that the type specimen as male but actually it is female.
Chilo gratiosellus Walker	Colombo (Sri Lanka)	-	+	-	BMNH	Lectotype female
Schoenobius minutellus Zeller	Java	+	-	-	BMNH	Lectotype male
Schoenobius punctellus Zeller	Java	-	+	-	BMNH	Lectotype female
Schoenobius bipunctifer ab *quadripunctellifera* Strand						
Sciropophaga nivella (Fabricius)	India	-	+	1	ZMC	Holotype female
Scirpophaga auriflua Zeller	Calcutta	-	+	1	BMNH	Holotype female
Scirpophaga brunnescens Moore	Calcutta	+	-	-	BMNH	Lectotype male
Scirpophaga celidias Meyrick	Borneo	+	-	-	BMNH	Lectotype male
Scirpophaga euclastalis Strand	Taiwan (Formosa)	+	-	1	IPE	Holotype male
Scirpophaga chrysorrhoea Zeller	Java	-	+	1	BMNH	Holotype female

ABBREVIATIONS USED

- BMNH British Museum (Natural History), London
- GAMB Gragorie Antipa Museum (Bucharest).
- ICG In Guenee's Collection
- ICM In Meyrick's Collection
- IMC Indian Museum, Calcutta
- IPE I P Eberwalde Collection
- ISC In Snellen's Collection
- MHNP Museum d' Histoire Naturelle, Paris
- MNHL Museum Van Naturlijke Histoire (Leiden)
- UMO University Museum, Oxford.
- ZIL Zoologitscheskij Institut (Leningard)
- ZMB Zoologisches Museum, Berlin
- ZMC Zoological Museum, Copenhagen (Denmark)

PLATES

AND

FIGURES

PLATE 1

GENERAL MORPHOLOGY

FIGURES	DETAILS
1	Generalized adult body
2	Dorsal view of body
3	Frontal view of head
4, 5	Lateral view of head
6	Antenna
7	Hairy eye
8	Lashed eye
9	Dorsal view of thorax

PLATE 1

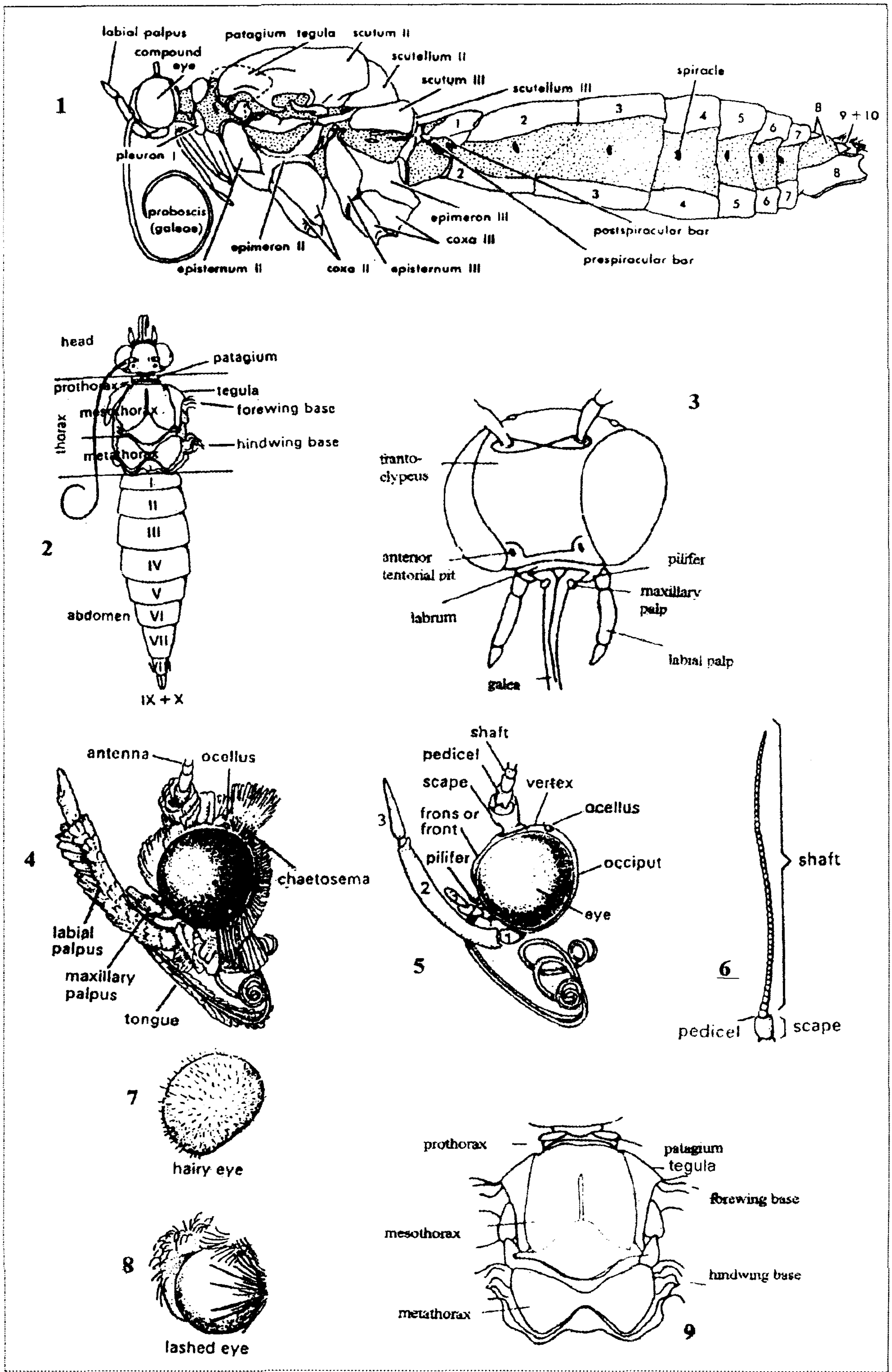
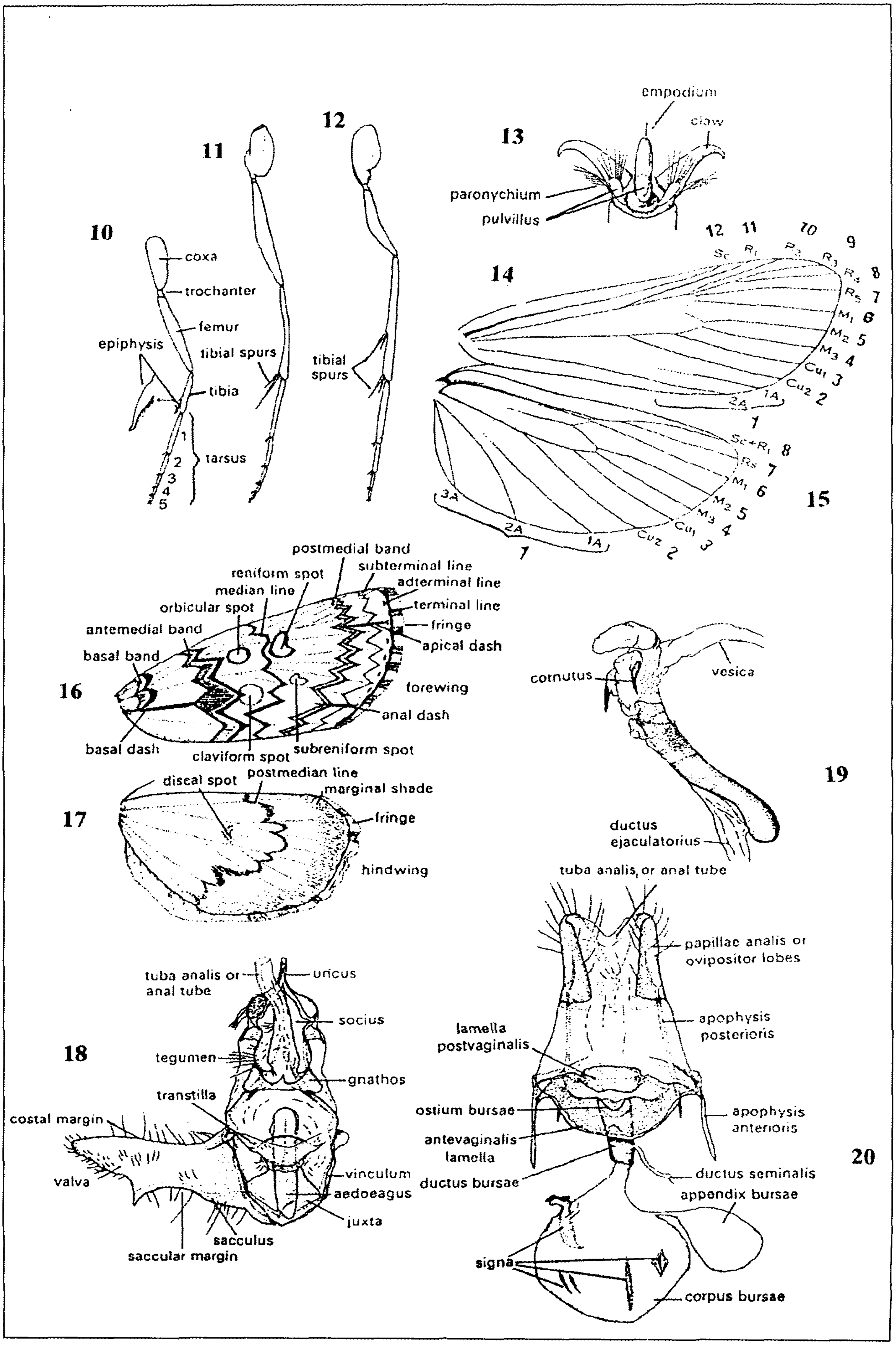

1
labial palpus
compound eye
patagium
tegula
scutum II
scutellum II
scutum III
scutellum III
spiracle
pleuron I
proboscis (galeae)
epimeron II
episternum II
coxa II
episternum III
epimeron III
coxa III
postspiracular bar
prespiracular bar
2
head
patagium
prothorax
tegula
mesothorax
forewing base
thorax
hindwing base
metathorax
abdomen
IX + X
3
tranto-clypeus
anterior tentorial pit
pilifer
maxillary palp
labrum
labial palp
galea
4
antenna
ocellus
chaetosema
labial palpus
maxillary palpus
tongue
5
shaft
pedicel
scape
vertex
ocellus
frons or front
pilifer
occiput
eye
6
shaft
pedicel
scape
7
hairy eye
8
lashed eye
9
prothorax
patagium
tegula
forewing base
mesothorax
hindwing base
metathorax

PLATE 2

GENERAL MORPHOLOGY

FIGURES	DETAILS
10, 11, 12	Fore leg, mid leg and hind leg, respectively
13	Pretarsus
14, 15	Fore and hind wing neuration
16, 17	Fore and hind wing pattern
18	Male genitalia
19	Aedeagus
20	Female genitalia

PLATE 2



10
coxa
trochanter
femur
epiphysis
tibia
tarsus
1
2
3
4
5
11
tibial spurs
12
tibial spurs
13
empodium
claw
paronychium
pulvillus
14
12 11 10 9 8 7 6 5 4 3 2 1
Sc
R1
R2
R3
R4
R5
M1
M2
M3
Cu1
Cu2
1A
2A
15
Sc+R1
Rs
M1
M2
M3
Cu1
Cu2
1A
2A
3A
8 7 6 5 4 3 2 1
16
postmedial band
reniform spot
subterminal line
median line
adterminal line
orbicular spot
terminal line
antemedial band
fringe
apical dash
basal band
forewing
anal dash
basal dash
claviform spot
subreniform spot
17
discal spot
postmedian line
marginal shade
fringe
hindwing
18
tuba analis or anal tube
uncus
socius
tegumen
gnathos
transtilla
costal margin
valva
vinculum
aedoeagus
juxta
sacculus
saccular margin
19
cornutus
vesica
ductus ejaculatorius
20
tuba analis or anal tube
papillae analis or ovipositor lobes
apophysis posterioris
lamella postvaginalis
ostium bursae
apophysis anterioris
antevaginalis lamella
ductus bursae
ductus seminalis
appendix bursae
signa
corpus bursae

PLATE 3

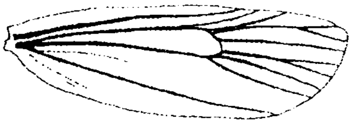
NEURATION

FIGURES	DETAILS
21 and 22	Fore and hind wing of *Maliarpha separatella* Ragonot
23 and 24	Fore and hind wing of *Saluria inficita* (Walker)
25 and 26	Fore and hind wing of *Ancylolomia chrysographella* (Kollar)
27 and 28	Fore and hind wing of *Borer sacchariphagus indicus* (Kapur)
29 and 30	Fore and hind wing of *Chilo partellus* (Swinhoe)
31 and 32	Fore and hind wing of *Chilo suppressalis* (Walker)
33 and 34	Fore and hind wing of *Chilotraea auricilia* (Dudgeon)
35 and 36	Fore and hind wing of *Chilotraea infuscatellus* (Snellen)

PLATE 3

21

22

23

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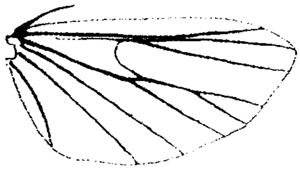
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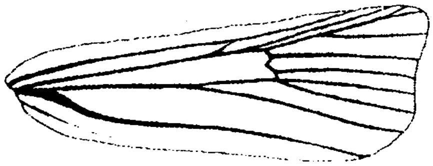
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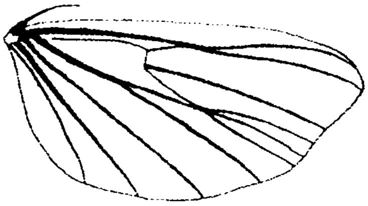
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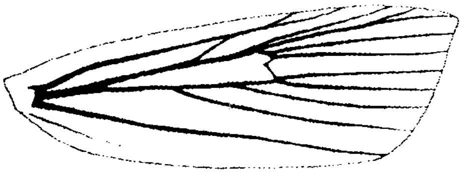
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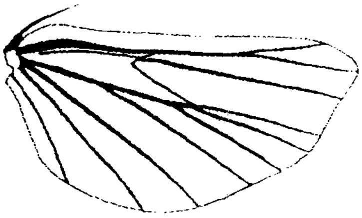
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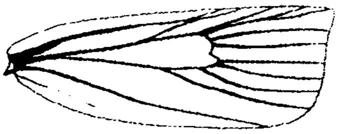
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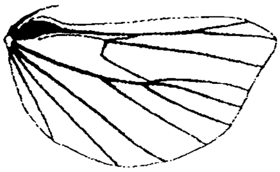
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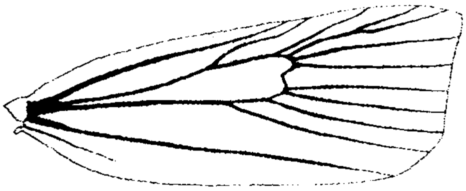
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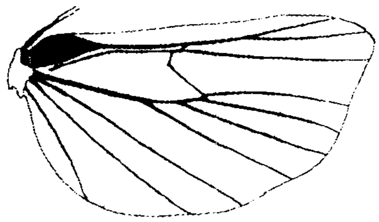
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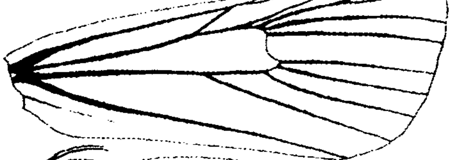
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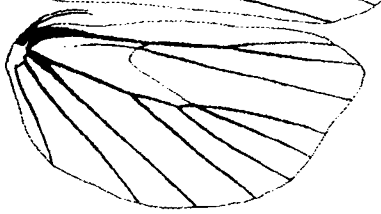
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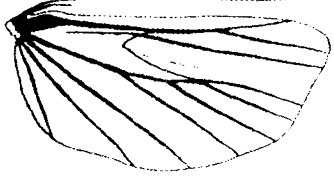

PLATE 4

NEURATION

FIGURES	DETAILS
37 and 38	Fore and hind wing of *Parapoynx fluctuosalis* (Zeller)
39 and 40	Fore and hind wing of *Parapoynx stagnalis* (Zeller)
41 and 42	Fore and hind wing of *Bradina admixtalis* (Walker)
43 and 44	Fore and hind wing of *Cnaphalocrocis medinalis* (Guenee)
45 and 46	Fore and hind wing of *Cnaphalocrocis poeyalis* (Boisduval)
47 and 48	Fore and hind wing of *Cnaphalocrocis suspicalis* (Walker)
49 and 50	Fore and hind wing of *Crypsiptya coclesalis* (Walker)
51 and 52	Fore and hind wing of *Herpetogramma licarcisalis* (Walker)
53 and 54	Fore and hind wing of *Herpetogramma phoeopteralis* (Guenee)

PLATE 4

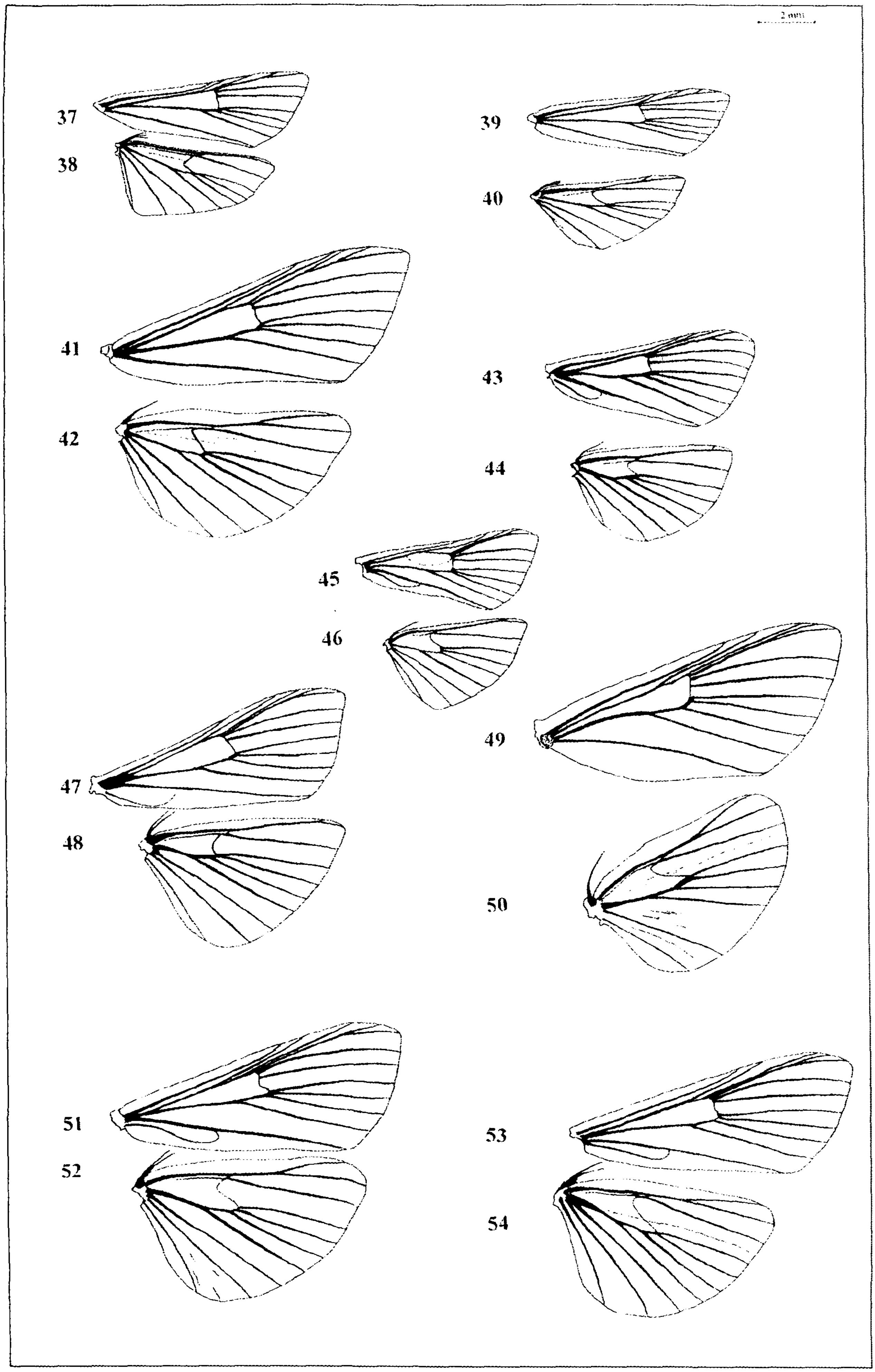

PLATE 5

NEURATION

FIGURES	DETAILS
55 and 56	Fore and hind wing of *Mabra eryxalis* (Walker)
57 and 58	Fore and hind wing of *Notarcha obrimusalis* (Walker)
59 and 60	Fore and hind wing of *Pleuroptya balteata* (Fabricius)
61 and 62	Fore and hind wing of *Schoenobius immeritalis* (Walker)
63 and 64	Fore and hind wing of *Scirpophaga fusciflua* Hampson
65 and 66	Fore and hind wing of *Scirpophaga gilviberbis* Zeller
67 and 68	Fore and hind wing of *Scirpophaga incertulas* (Walker)
69 and 70	Fore and hind wing of *Scirpophaga nivella* (Fabricius)

PLATE 5

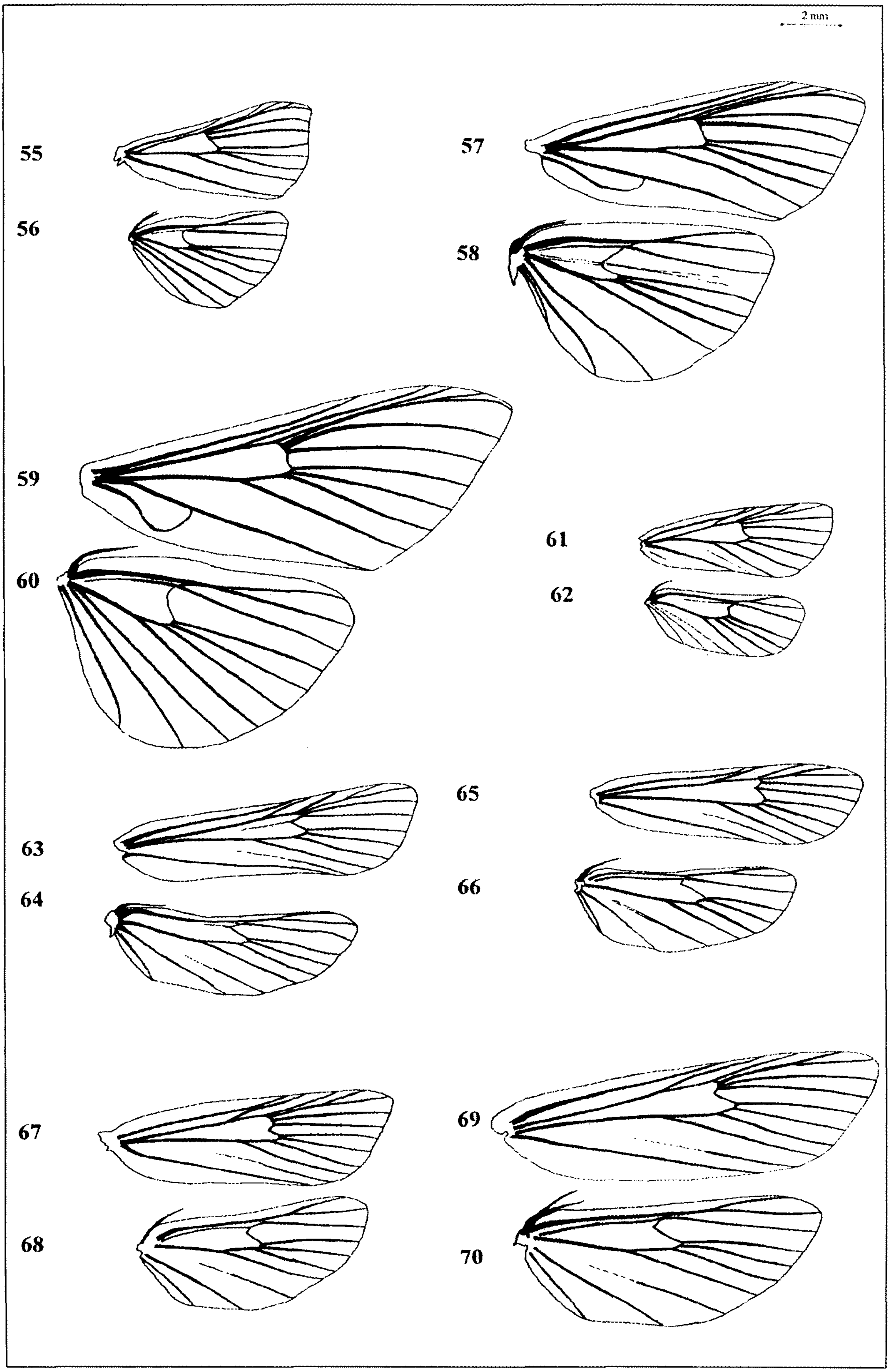

PLATE 6

LEGS

FIGURES	DETAILS
71, 72 and 73	Fore, mid and hind legs of *Maliarpha separatella* Ragonot
74, 75 and 76	Fore, mid and hind legs of *Saluria inficita* (Walker)
77, 78 and 79	Fore, mid and hind legs of *Ancylolomia chrysographella* (Kollar)
80, 81 and 82	Fore, mid and hind legs of *Borer sacchariphagus indicus* (Kapur)
83, 84 and 85	Fore, mid and hind legs of *Chilo partellus* (Swinhoe)

PLATE 6

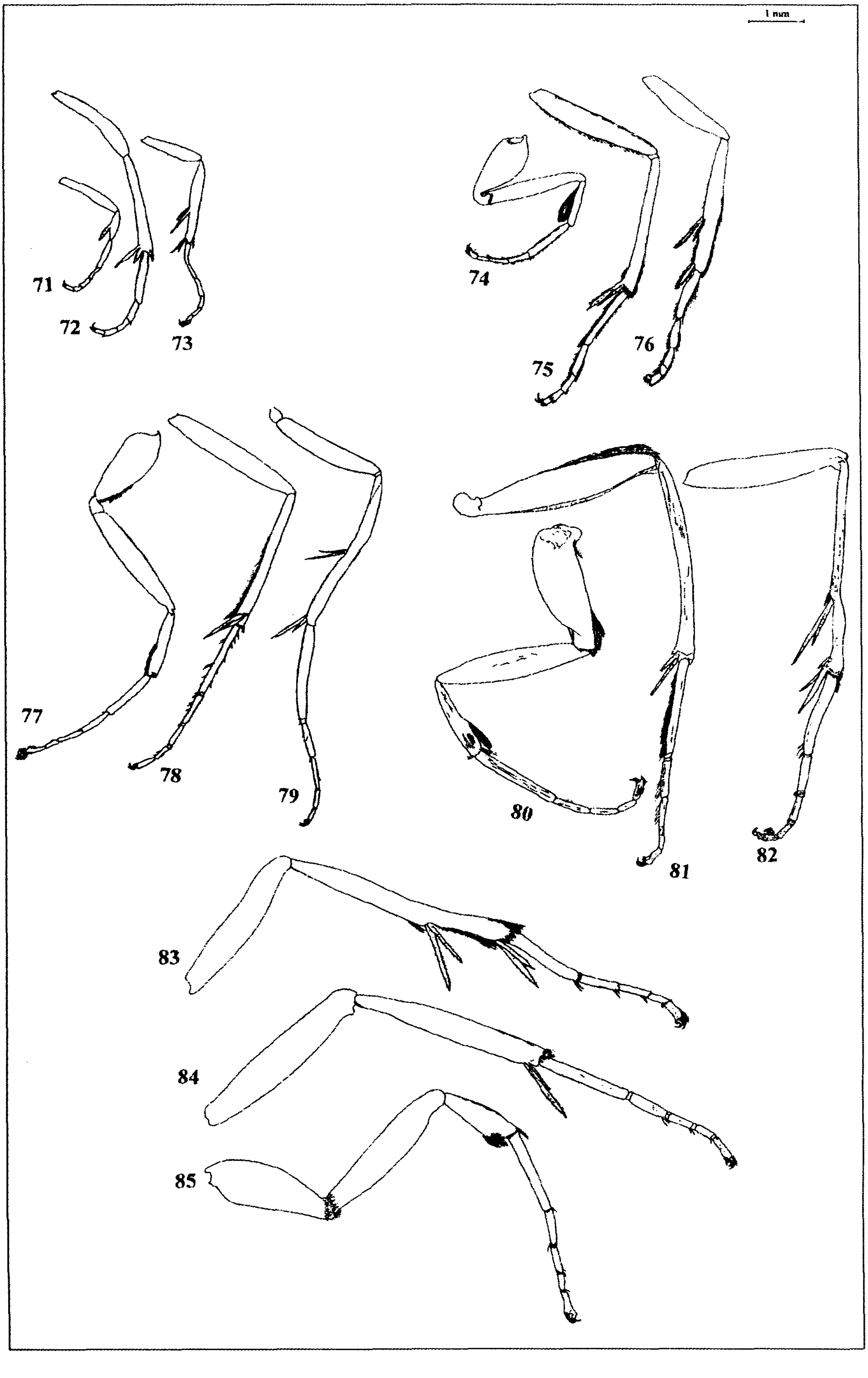

PLATE 7

LEGS

FIGURES	DETAILS
86, 87 and 88	Fore, mid and hind legs of *Chilo suppressalis* (Walker)
89, 90 and 91	Fore, mid and hind legs of *Chilotraea auricilia* (Dudgeon)
92, 93 and 94	Fore, mid and hind legs of *Chilotraea infuscatellus* (Snellen)
95, 96 and 97	Fore, mid and hind legs of *Parapoynx fluctuosalis* (Zeller)
98, 99 and 100	Fore, mid and hind legs of *Parapoynx stagnalis* (Zeller)

PLATE 7

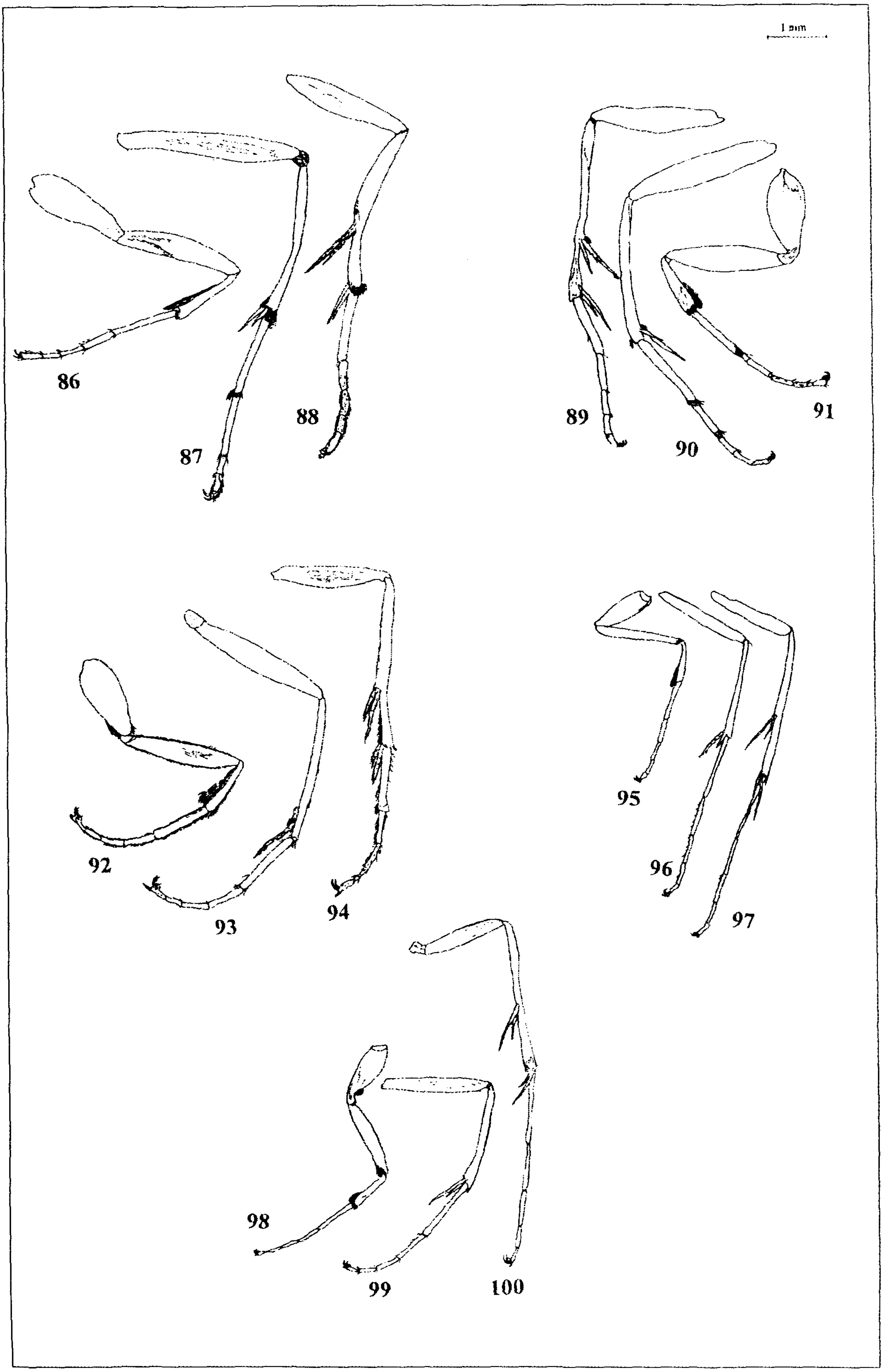

PLATE 8

LEGS

FIGURES	DETAILS
101, 102 and 103	Fore, mid and hind legs of *Bradina admixtalis* (Walker)
104, 105 and 106	Fore, mid and hind legs of *Cnaphalocrocis medinalis* (Guenee)
107, 108 and 109	Fore, mid and hind legs of *Cnaphalocrocis poeyalis* (Boisduval)
110, 111 and 112	Fore, mid and hind legs of *Cnaphalocrocis suspicalis* (Walker)
113, 114 and 115	Fore, mid and hind legs of *Crypsiptya coclesalis* (Walker)

PLATE 8

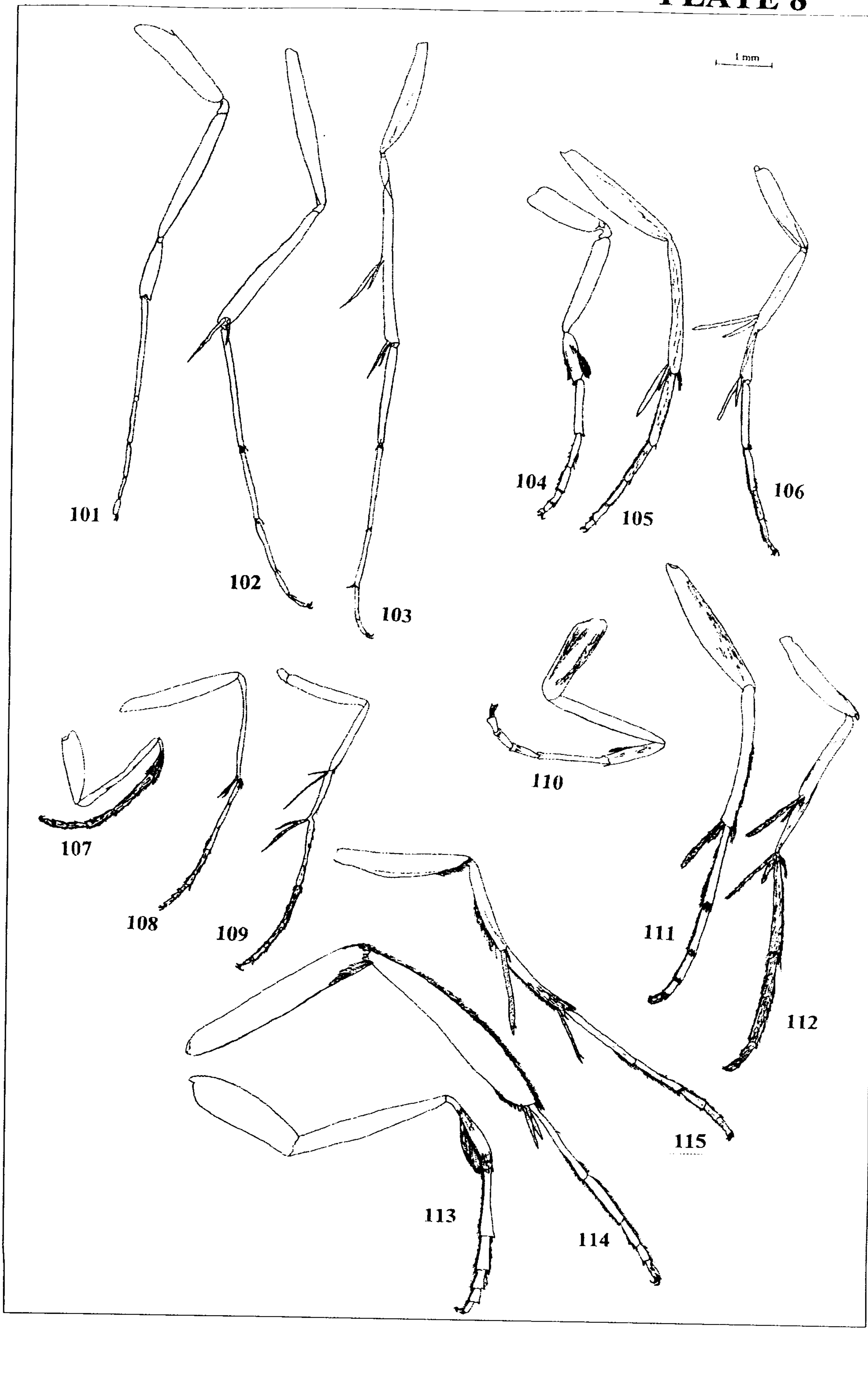

PLATE 9

LEGS

FIGURES	DETAILS
116, 117 and 118	Fore, mid and hind legs of *Herpetogramma licarcisalis* (Walker)
119, 120 and 121	Fore, mid and hind legs of *Herpetogramma phoeopteralis* (Guenee)
122, 123 and 124	Fore, mid and hind legs of *Mabra eryxalis* (Walker)
125, 126 and 127	Fore, mid and hind legs of *Notarcha obrinusalis* (Walker)
128, 129 and 130	Fore, mid and hind legs of *Pleuroptya balteata* (Fabricius)

PLATE 9

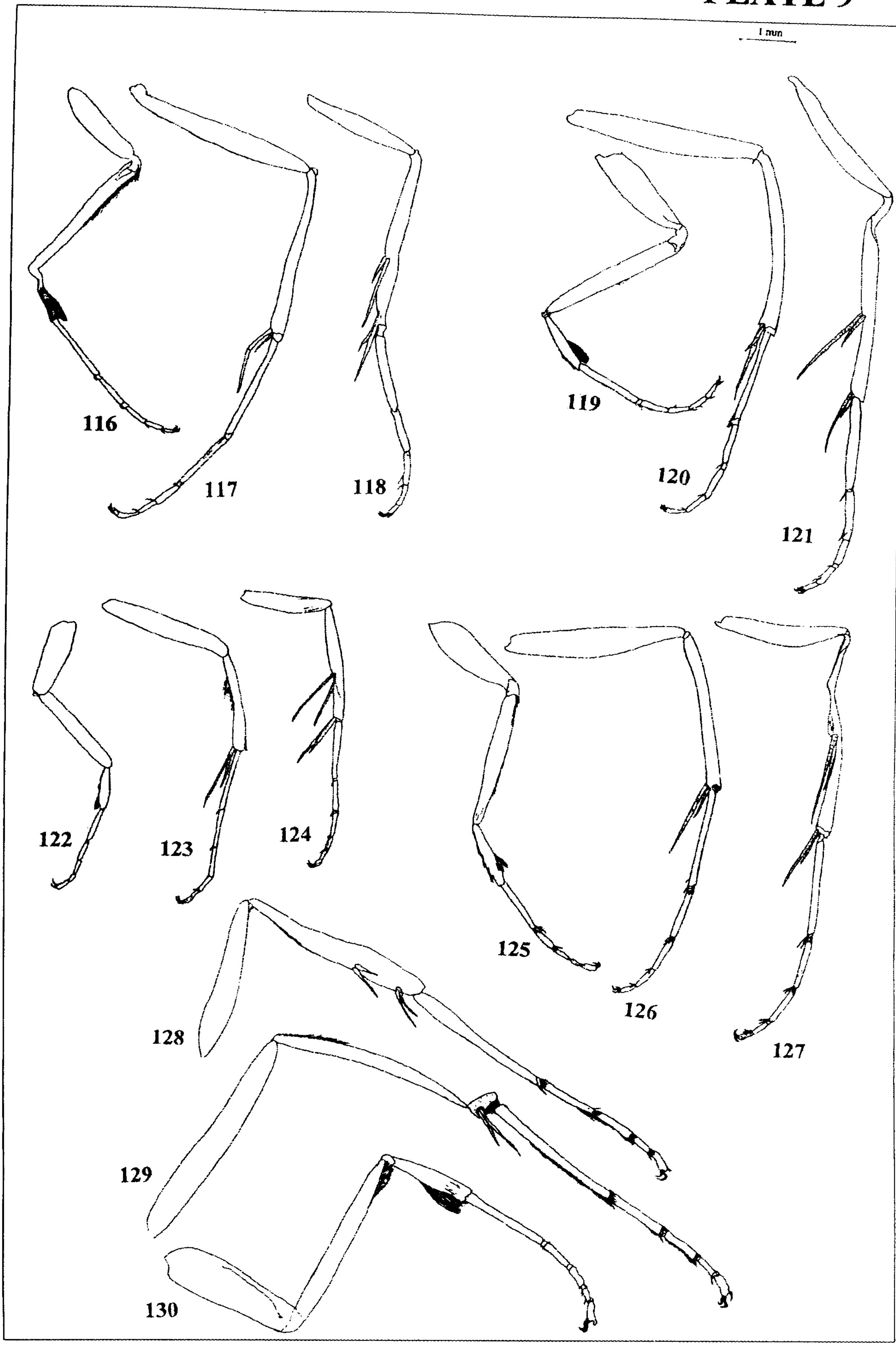

PLATE 10

LEGS

FIGURES	DETAILS
131, 121 and 133	Fore, mid and hind legs of *Schoenobius immeritalis* (Walker)
134, 135and 136	Fore, mid and hind legs of *Scirpophaga fusciflua* Hampson
137, 138 and 139	Fore, mid and hind legs of *Scirpophaga gilviberbis* Zeller
140, 141 and 142	Fore, mid and hind legs of *Scirpophaga incertulas* (Walker)
143, 144 and 145	Fore, mid and hind legs of *Scirpophaga nivella* (Fabricius)

PLATE 10

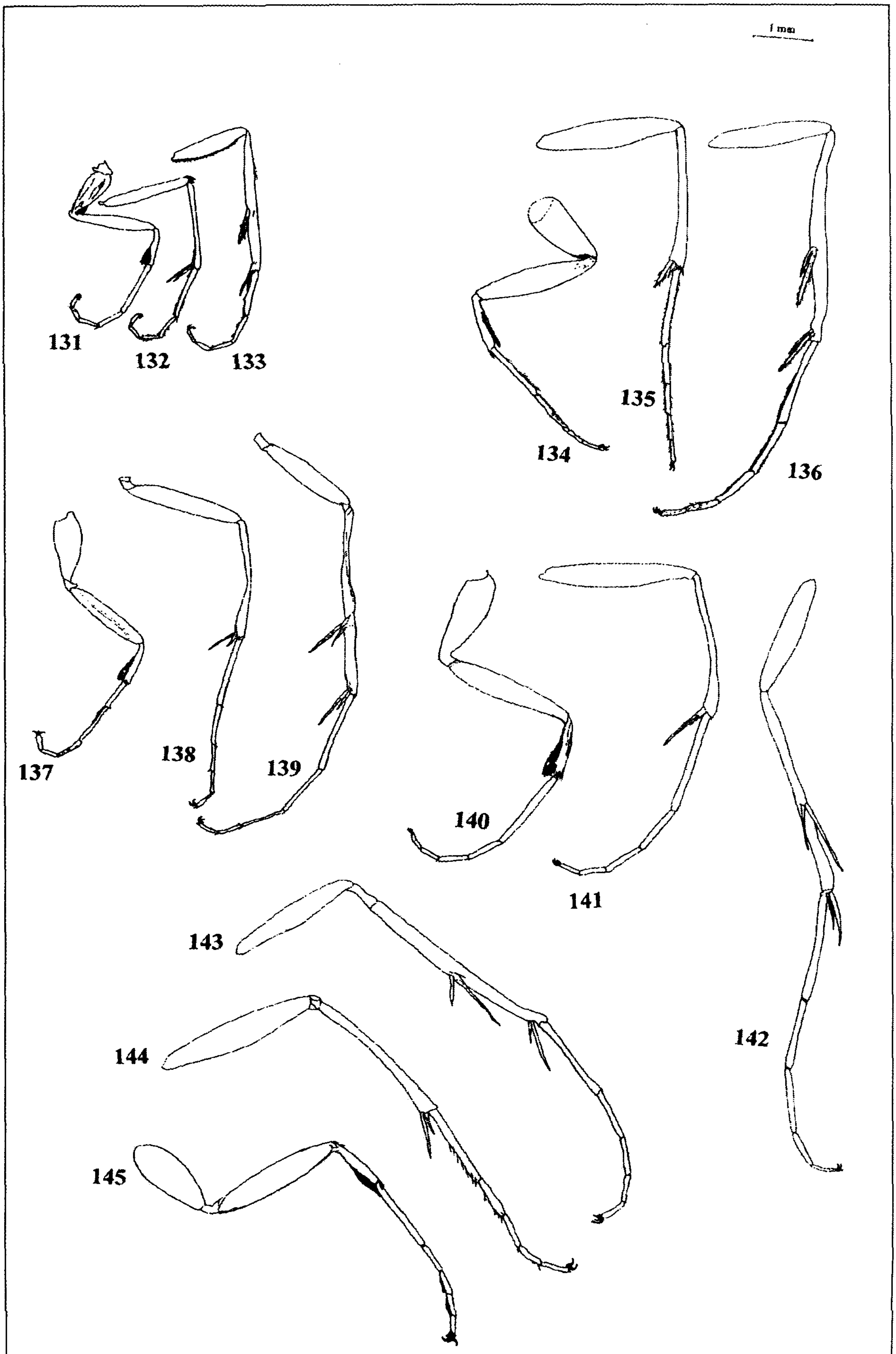

PLATE 11

MALE GENITALIA

FIGURES	DETAILS
146 and 147	*Maliarpha separatella* Ragonot
148 and 149	*Saluria inficita* (Walker)
150, 151 and 152	*Ancylolomia chrysographella* (Kollar)
153, 154 and 155	*Borer sacchariphagus indicus* (Kapur)
156, 157 and 158	*Chilo partellus* (Swinhoe)
159, 160 and 161	*Chilo suppressalis* (Walker)

PLATE 11

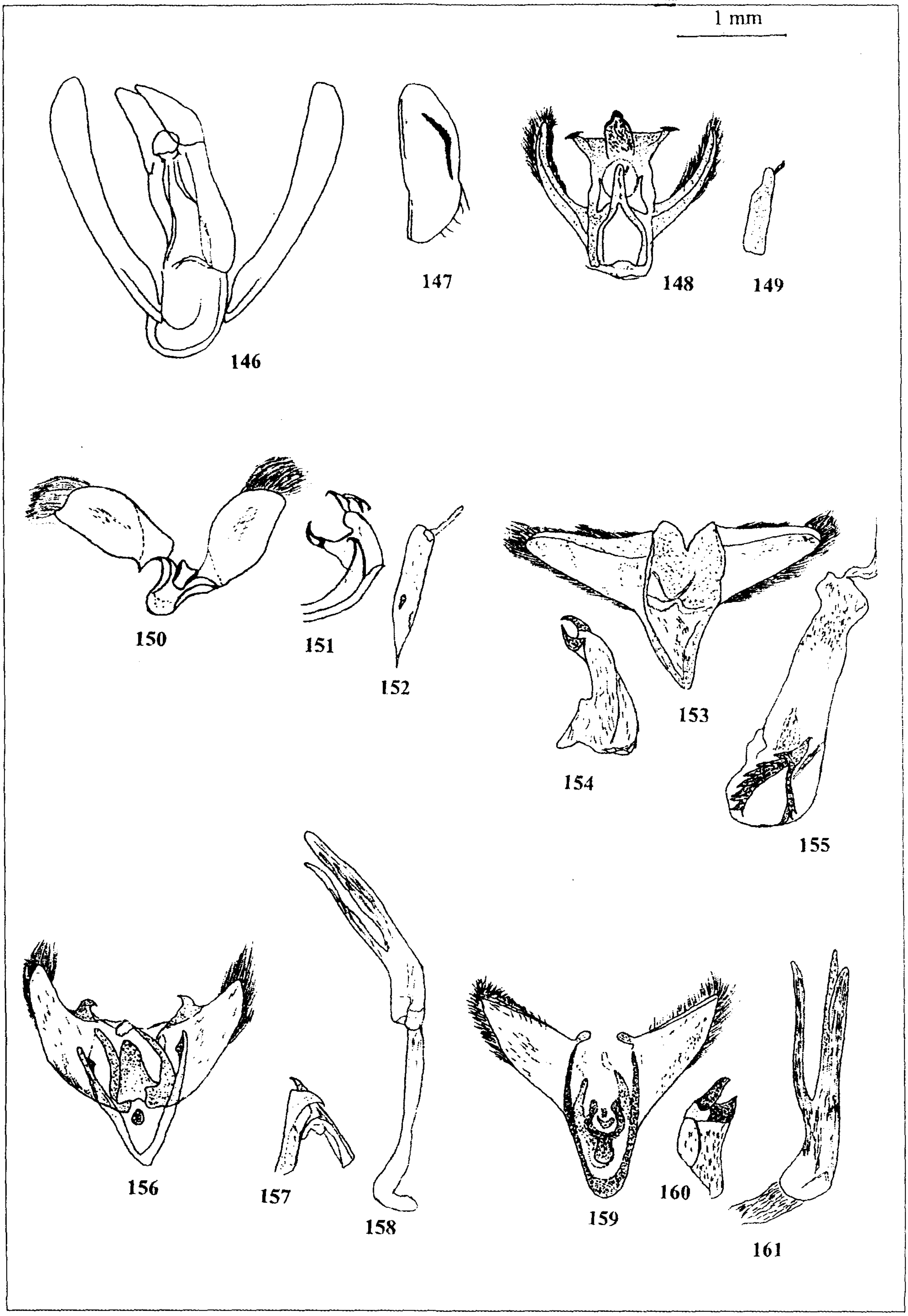
1 mm
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PLATE 12

MALE GENITALIA

FIGURES	DETAILS
162, 163 and 164	*Chilotraea auricilia* (Dudgeon)
165, 166 and 167	*Chilotraea infuscatellus* (Snellen)
168, 169 and 170	*Parapoynx fluctuosalis* (Zeller)
171and 172	*Parapoynx stagnalis* (Zeller)
173and 174	*Bradina admixtalis* (Walker)
175and 176	*Cnaphalocrocis medinalis* (Guenee)

PLATE 12

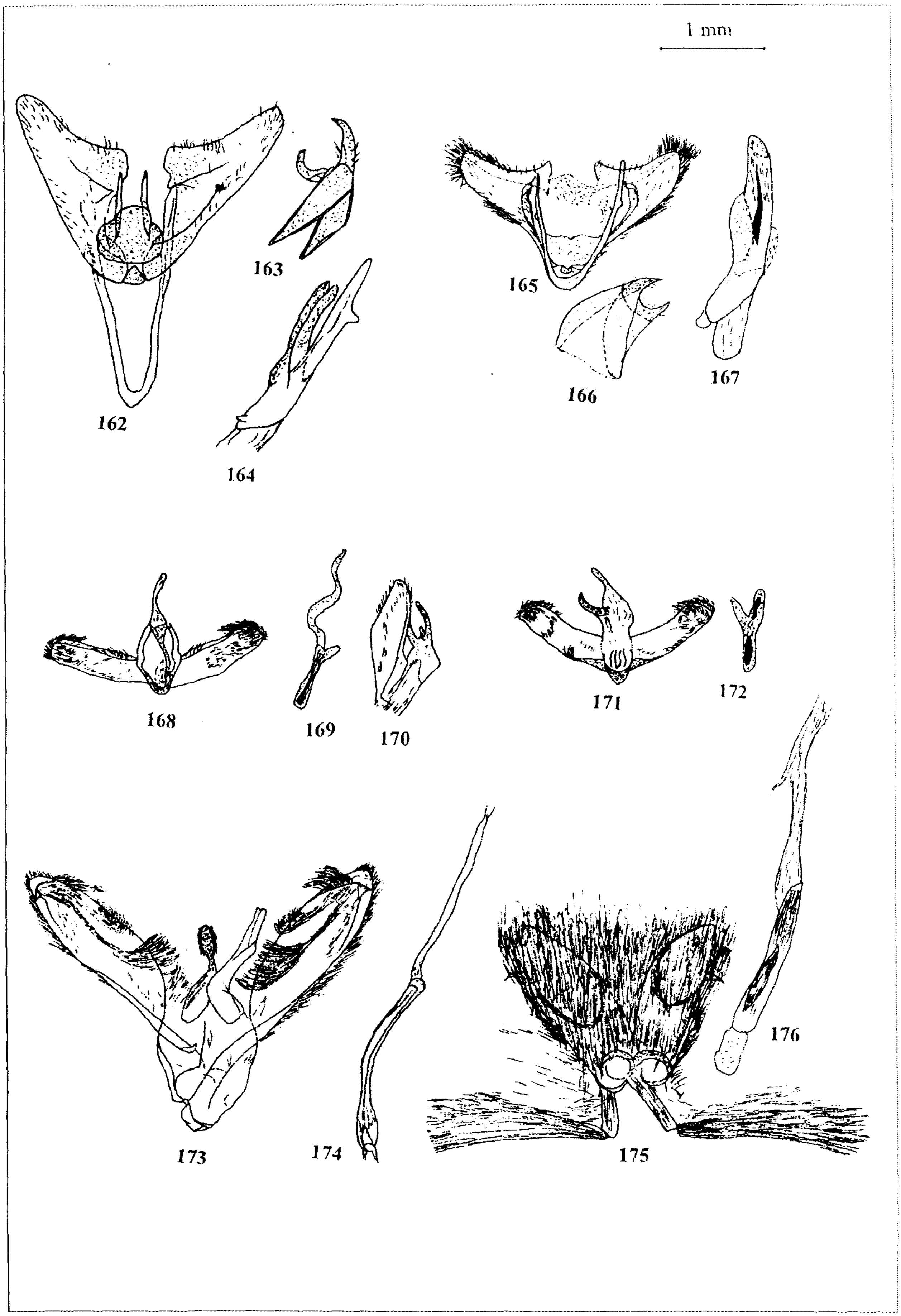


PLATE 13

MALE GENITALIA

FIGURES	DETAILS
177and 178	*Cnaphalocrocis poeyalis* (Boisduval)
179and 180	*Cnaphalocrocis suspicalis* (Walker)
181and 182	*Crypsiptya coclesalis* (Walker)
183and 184	*Herpetogramma licarcisalis* (Walker)
185and 186	*Herpetogramma phoeopteralis* (Guenee)
187and 188	*Mabra eryxalis* (Walker)

PLATE 13

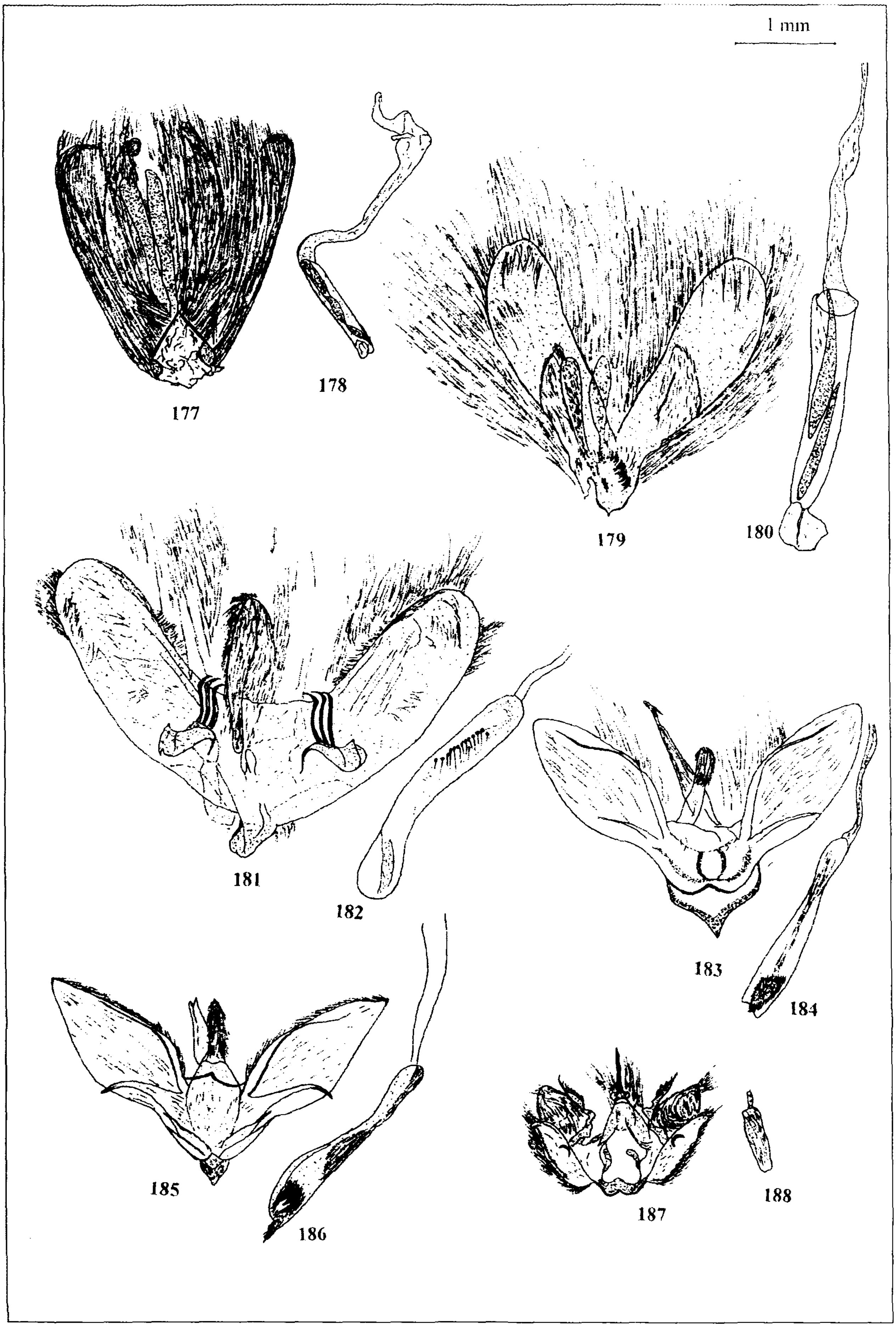


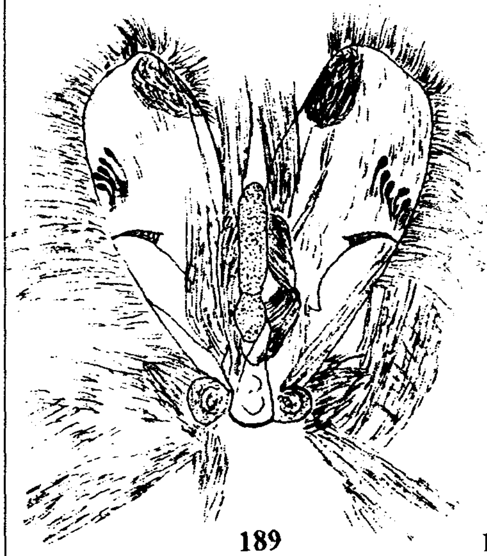
PLATE 14

MALE GENITALIA

FIGURES	DETAILS
189 and 190	*Notarcha obrimusalis* (Walker)
191 and 192	*Pleuroptya balteata* (Fabricius)
193 and 194	*Schoenobius immeritalis* (Walker)
195 and 196	*Scirpophaga gilviberbis* Zeller
197 and 198	*Scirpophaga incertulas* (Walker)
199 and 200	*Scirpophaga nivella* (Fabricius)

PLATE 14

1 mm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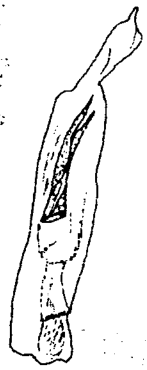
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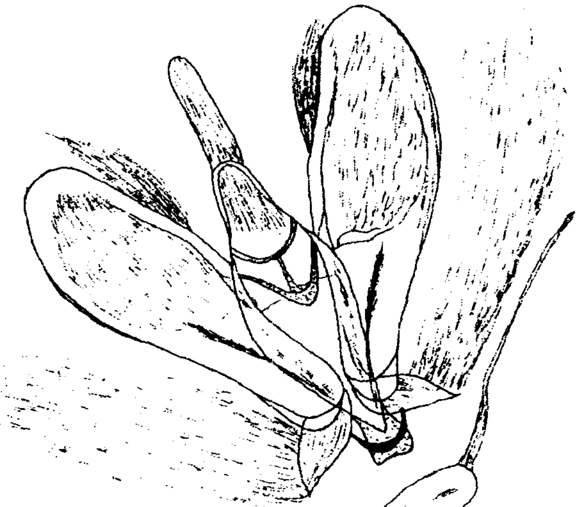
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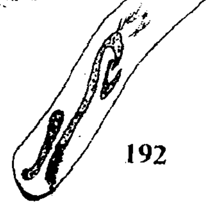
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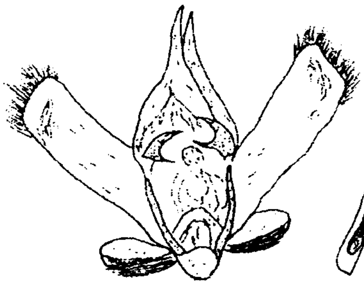
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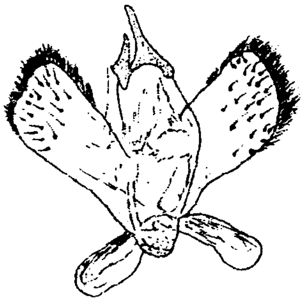
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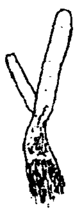
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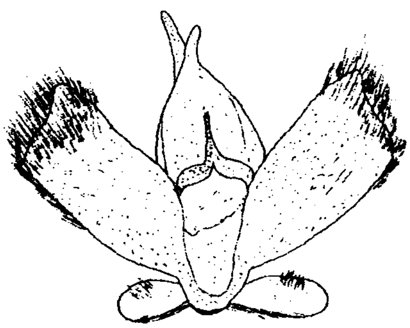
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PLATE 15

FEMALE GENITALIA

FIGURES	DETAILS
201	*Maliarpha separatella* Ragonot
202	*Saluria inficita* (Walker)
203	*Ancylolomia chrysographella* (Kollar)
204	*Borer sacchariphagus indicus* (Kapur)
205	*Chilo partellus* (Swinhoe)
206	*Chilo suppressalis* (Walker)

PLATE 15

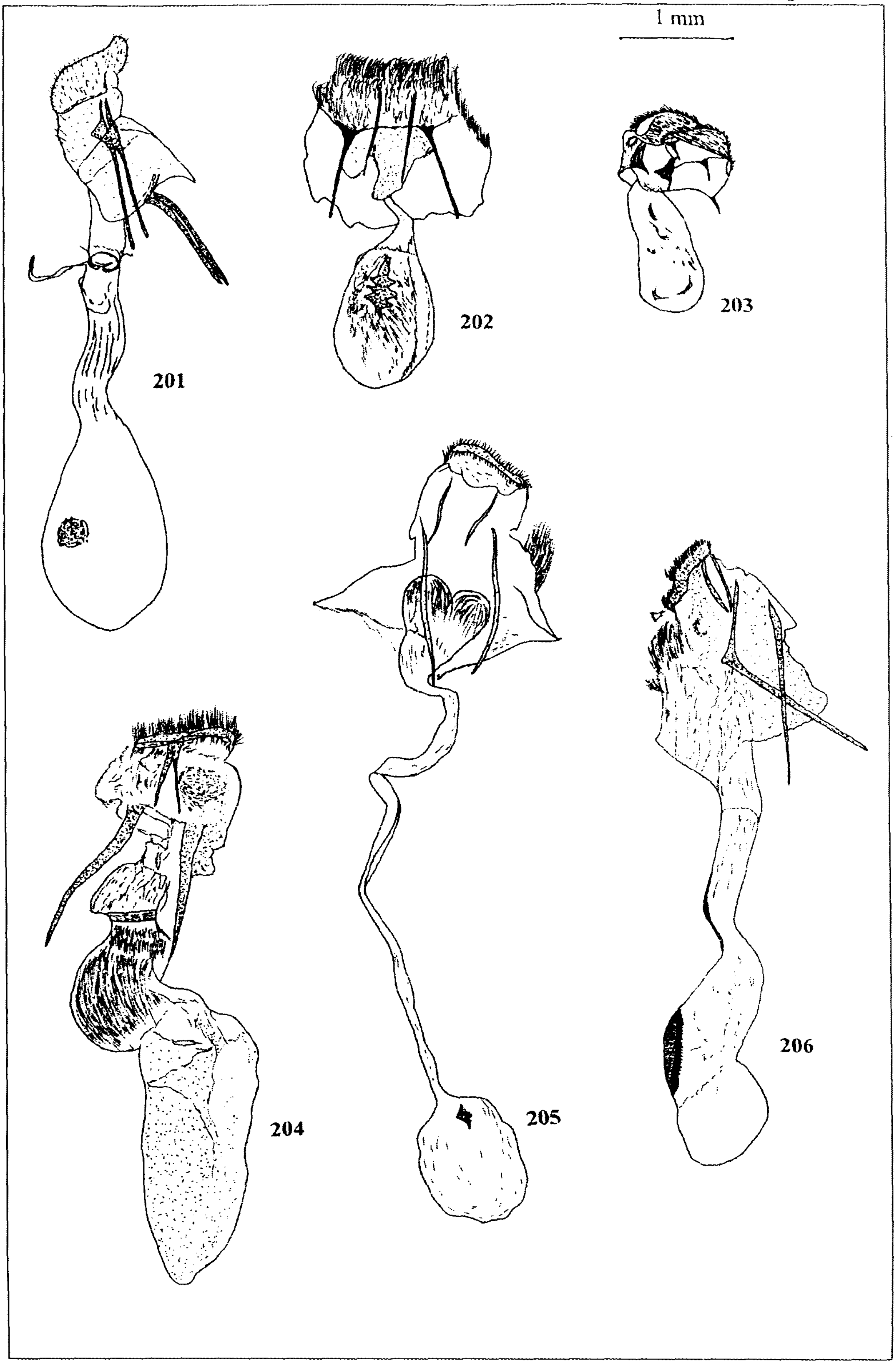


PLATE 16

FEMALE GENITALIA

FIGURES	DETAILS
207	*Chilotraea auricilia* (Dudgeon)
208	*Chilotraea infuscatellus* (Snellen)
209	*Parapoynx fluctuosalis* (Zeller)
210	*Parapoynx stagnalis* (Zeller)
211	*Bradina admixtalis* (Walker)
212	*Cnaphalocrocis medinalis* (Guenee)

PLATE 16

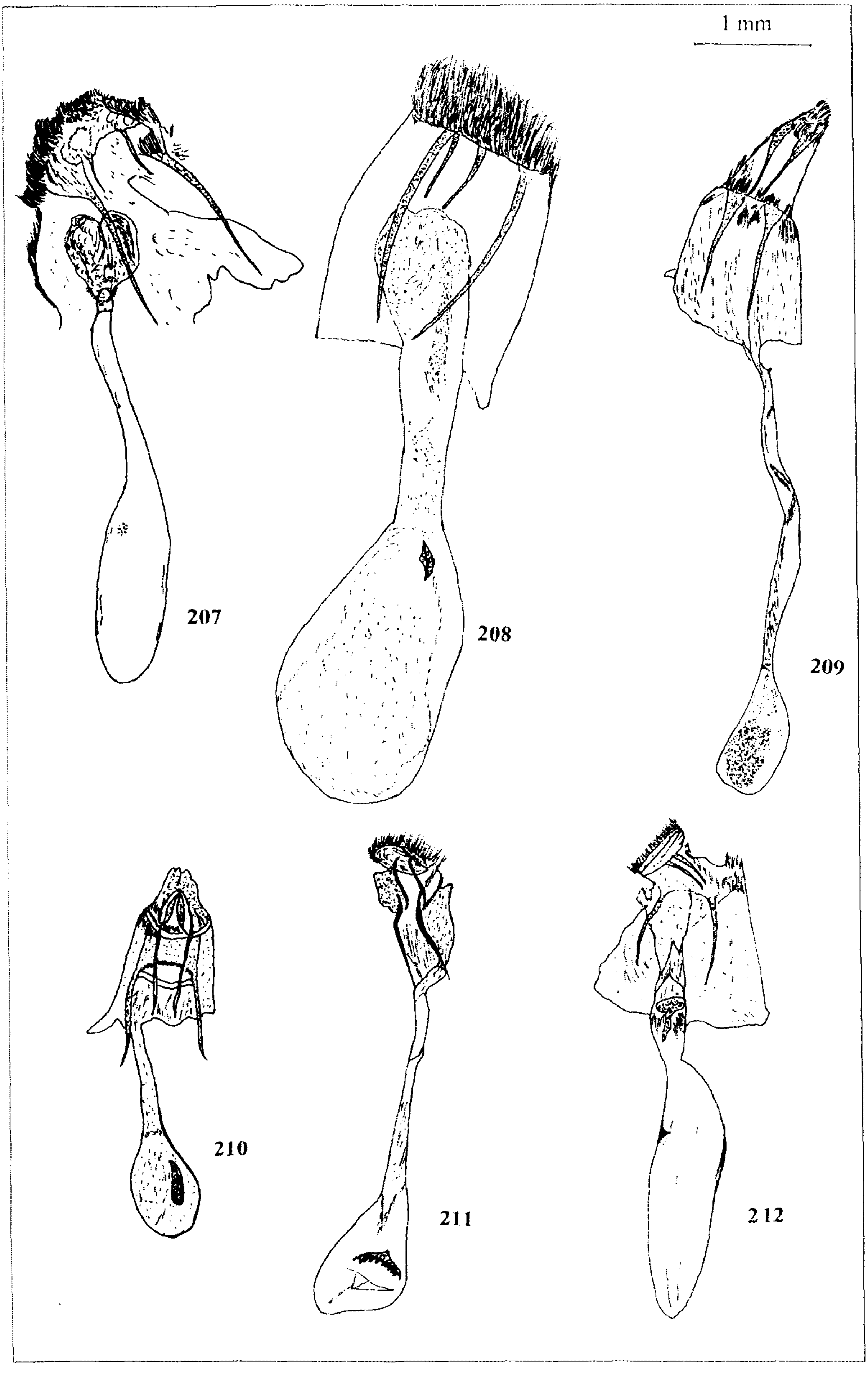


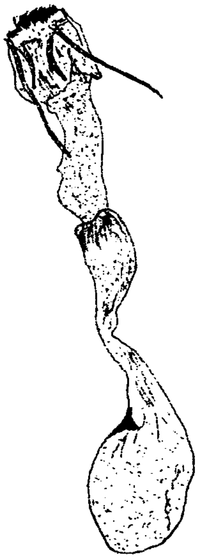
PLATE 17

FEMALE GENITALIA

FIGURES	DETAILS
213	*Cnaphalocrocis poeyalis* (Boisduval)
214	*Cnaphalocrocis suspicalis* (Walker)
215	*Crypsiptya coclesalis* (Walker)
216	*Herpetogramma licarcisalis* (Walker)
217	*Herpetogramma phoeopteralis* (Guenee)
218	*Mabra eryxalis* (Walker)

PLATE 17

1 mm



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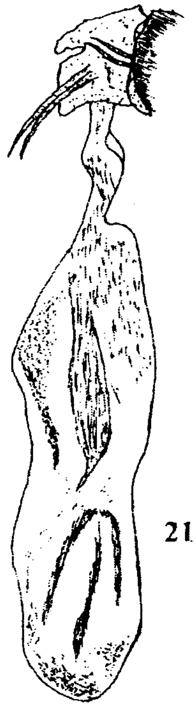

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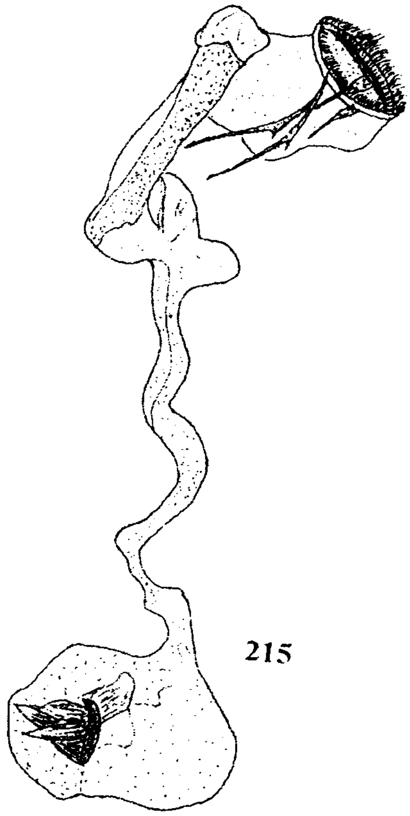

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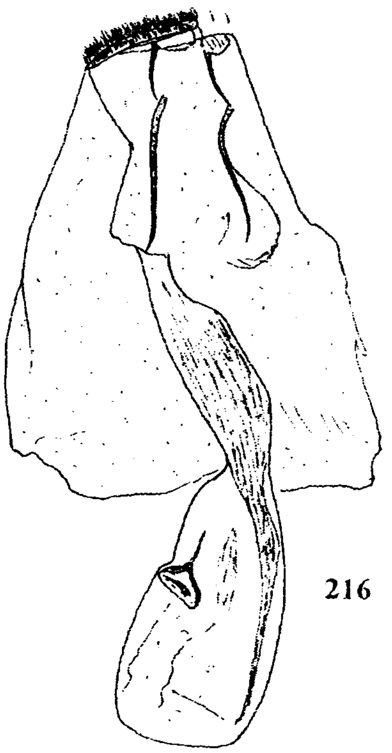

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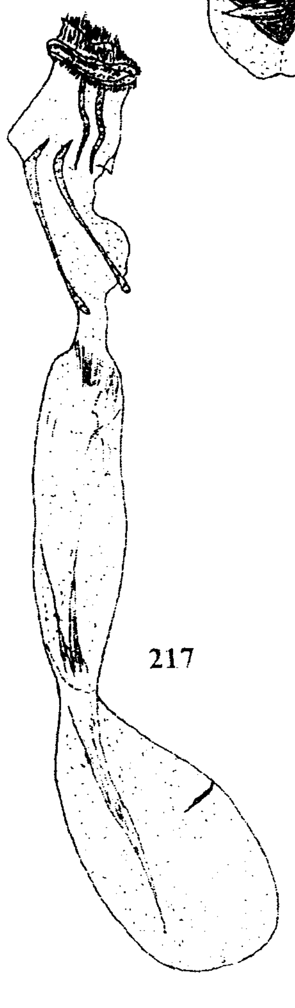

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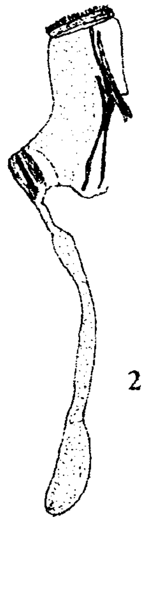

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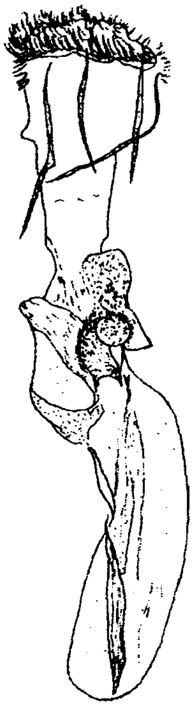
PLATE 18

FEMALE GENITALIA

FIGURES	DETAILS
219	*Notarcha obrinusalis* (Walker)
220	*Pleuroptya balteata* (Fabricius)
221	*Schoenobius immeritalis* (Walker)
222	*Scirpophaga fusciflua* Hampson
223	*Scirpophaga gilviberbis* Zeller
224	*Scirpophaga incertulas* (Walker)
225	*Scirpophaga nivella* (Fabricius)

PLATE 18

1 mm



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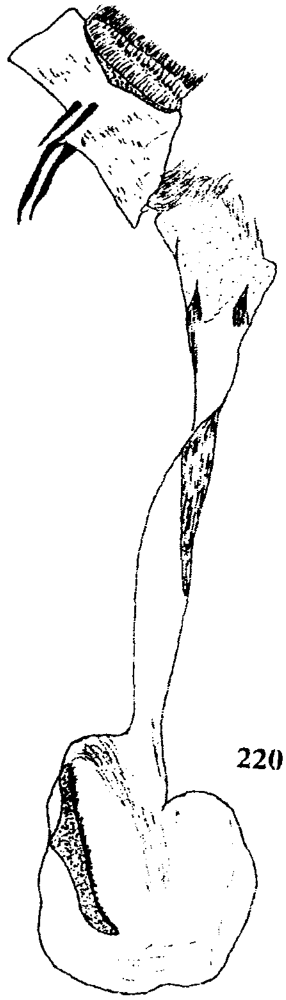

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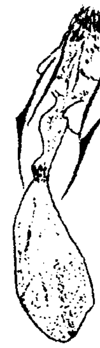

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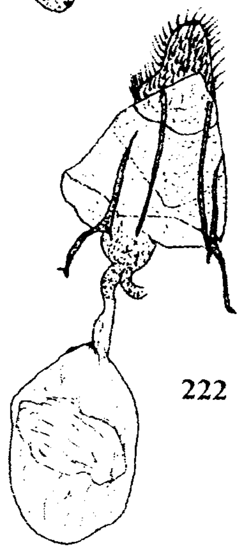

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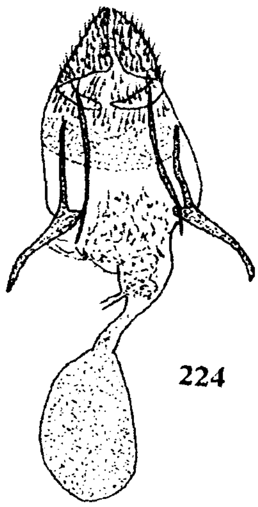

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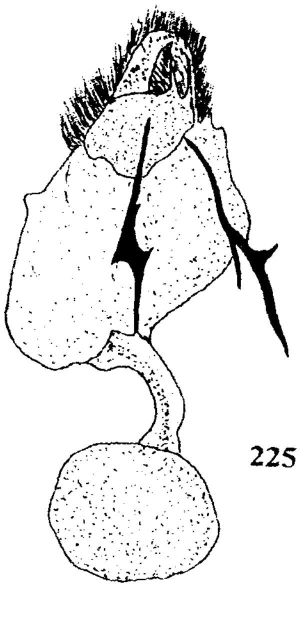

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PLATE 19

LATERAL VIEW OF ENLARGED HEAD AND LABIAL PALPI

FIGSURS	DETAILS
226	*Maliarpha separatella* Ragonot
227	*Saluria inficita* (Walker)
228	*Ancylolomia chrysographella* (Kollar)
229	*Borer sacchariphagus indicus* (Kapur)
230	*Chilo partellus* (Swinhoe)
231	*Chilo suppressalis* (Walker)
232	*Chilotraea auricilia* (Dudgeon)
233	*Chilotraea infuscatellus* (Snellen)
234	*Parapoynx fluctuosalis* (Zeller)
235	*Parapoynx stagnalis* (Zeller)
236	*Bradina admixtalis* (Walker)
237	*Cnaphalocrocis medinalis* (Guenee)
238	*Cnaphalocrocis poeyalis* (Boisduval)
239	*Cnaphalocrocis suspicalis* (Walker)
240	*Crypsiptya coclesalis* (Walker)
241	*Herpetogramma licarcisalis* (Walker)
242	*Herpetogramma phoeopteralis* (Guenee)
243	*Mabra eryxalis* (Walker)
244	*Notarcha obrinusalis* (Walker)
245	*Pleuroptya balteata* (Fabricius)
246	*Schoenobius immeritalis* (Walker)
247	*Scirpophaga fusciflua* Hampson
248	*Scirpophaga gilviberbis* Zeller
249	*Scirpophaga incertulas* (Walker)
250	*Scirpophaga nivella* (Fabricius)

Plate 19


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PLATE 20

DORSAL VIEW OF ADULTS

FIGSURS	DETAILS
251, female; 252, male	*Maliarpha separatella* Ragonot
253, female ; 254, male	*Saluria inficita* (Walker)
255, female ; 256, male	*Ancylolomia chrysographella* (Kollar)
257, female; 258, male	*Borer sacchariphagus indicus* (Kapur)
259, female; 260, male	*Chilo partellus* (Swinhoe)

Plate 20

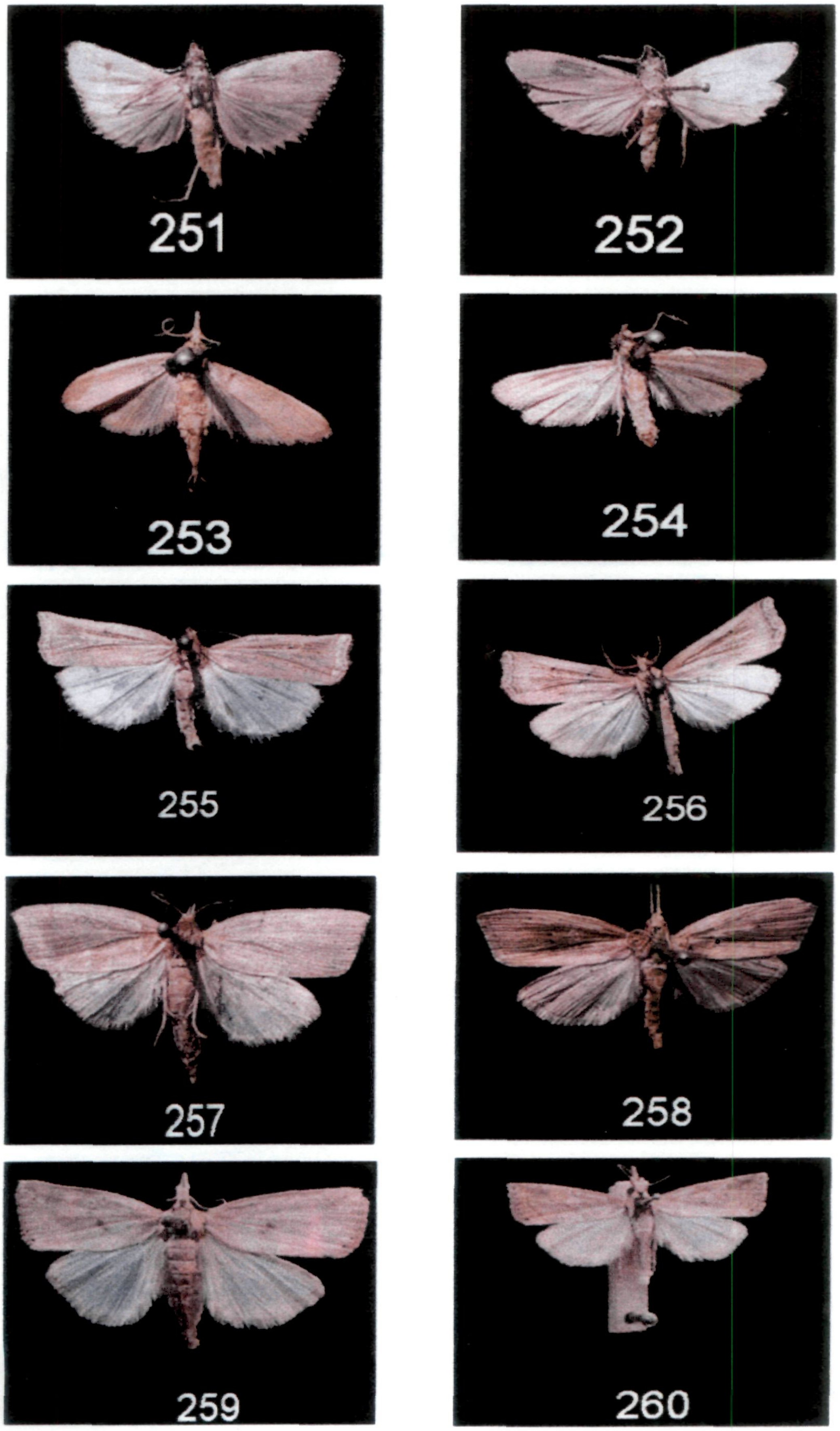
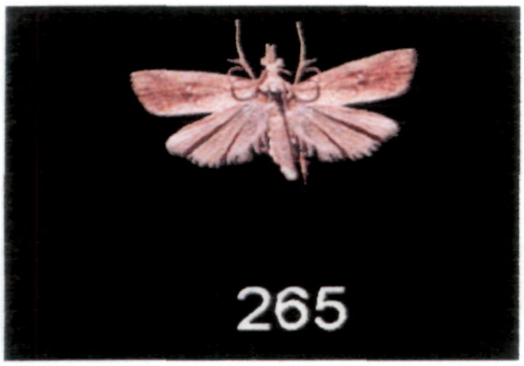


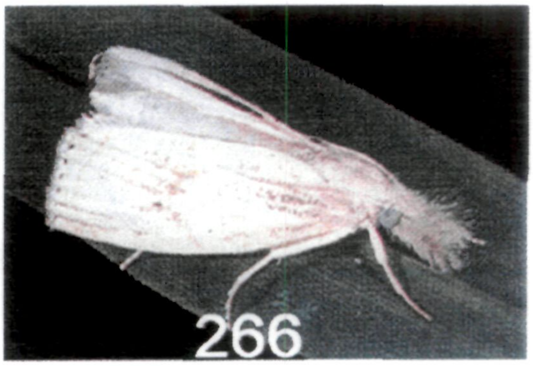
PLATE 21

DORSAL VIEW OF ADULTS

FIGSURS	DETAILS
261, female. 262, male	
263	*Chilo suppressalis* (Walker)
264, female: 265, male	
266	*Chilotraea auricilia* (Dudgeon
267,female. 268 male	*Chilotraea infuscatellus* (Snellen)

Plate 21





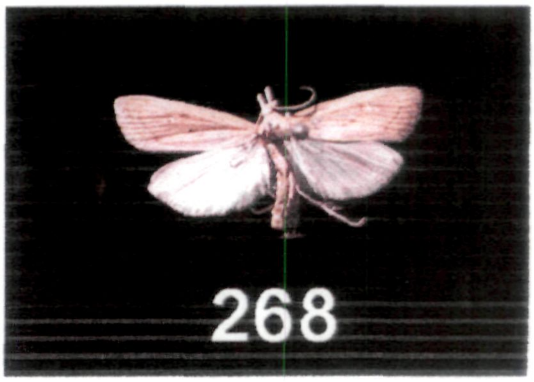


PLATE 22

DORSAL VIEW OF ADULTS

FIGSURS	DETAILS
268a	*Chilotraea polychrysa* (Meyrick)
269 female; 270 male	
271	*Parapoynx fluctuosalis* (Zeller)
272, female; 273, male	
274, 275	*Parapoynx stagnalis* (Zeller)

Plate 22

268a

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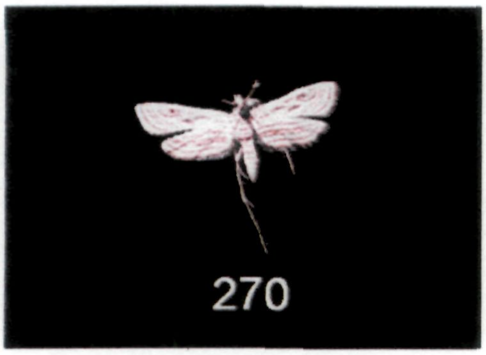

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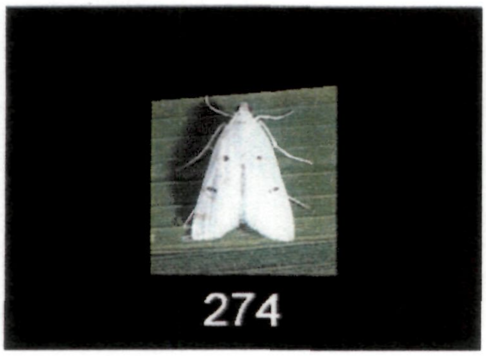

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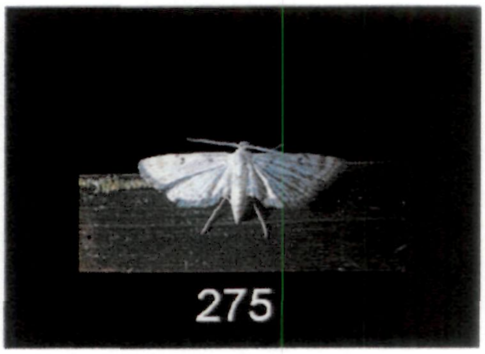

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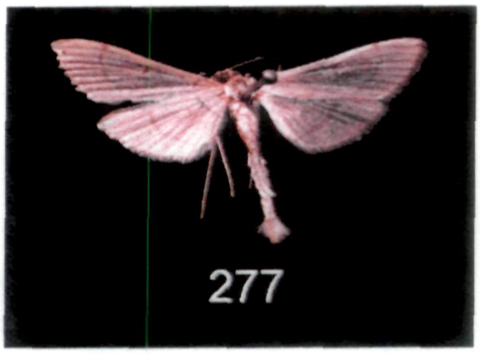
PLATE 23

DORSAL VIEW OF ADULTS

FIGSURS	DETAILS
276, female; 277, male	*Bradina admixtalis* (Walker)
278, female; 279 male	*Cnaphalocrocis medinalis* (Guenee)
280	*Cnaphalocrocis patnalis* (Bradley)
281, female; 282, male	*Cnaphalocrocis poeyalis* (Boisduval)
283, female; 284, male	*Cnaphalocrocis suspicalis* (Walker)


276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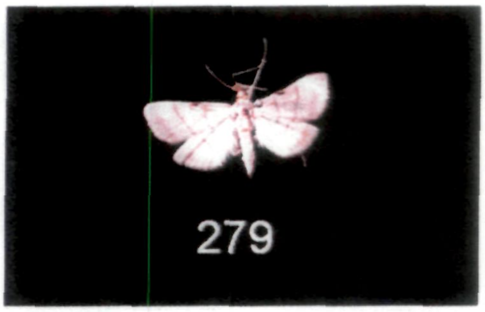
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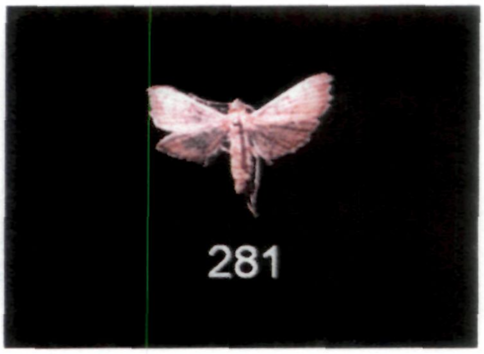
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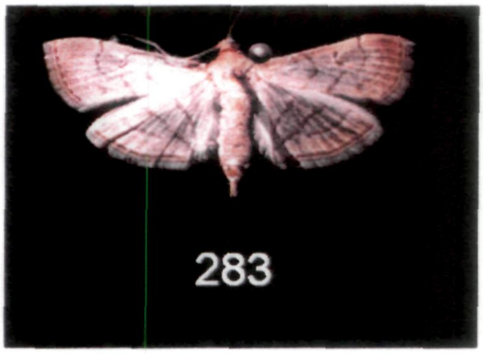
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PLATE 24

DORSAL VIEW OF ADULTS

FIGSURS	DETAILS
285, female; 286, male	*Crypsiptya coclesalis* (Walker)
287, female; 288, male	
289	*Herpetogramma licarcisalis* (Walker)
290, female; 291, male	*Herpetogramm phoeopteralis* (Guenee)
292, female; 293, male	*Mabra eryxalis* (Walker)

Plate 24

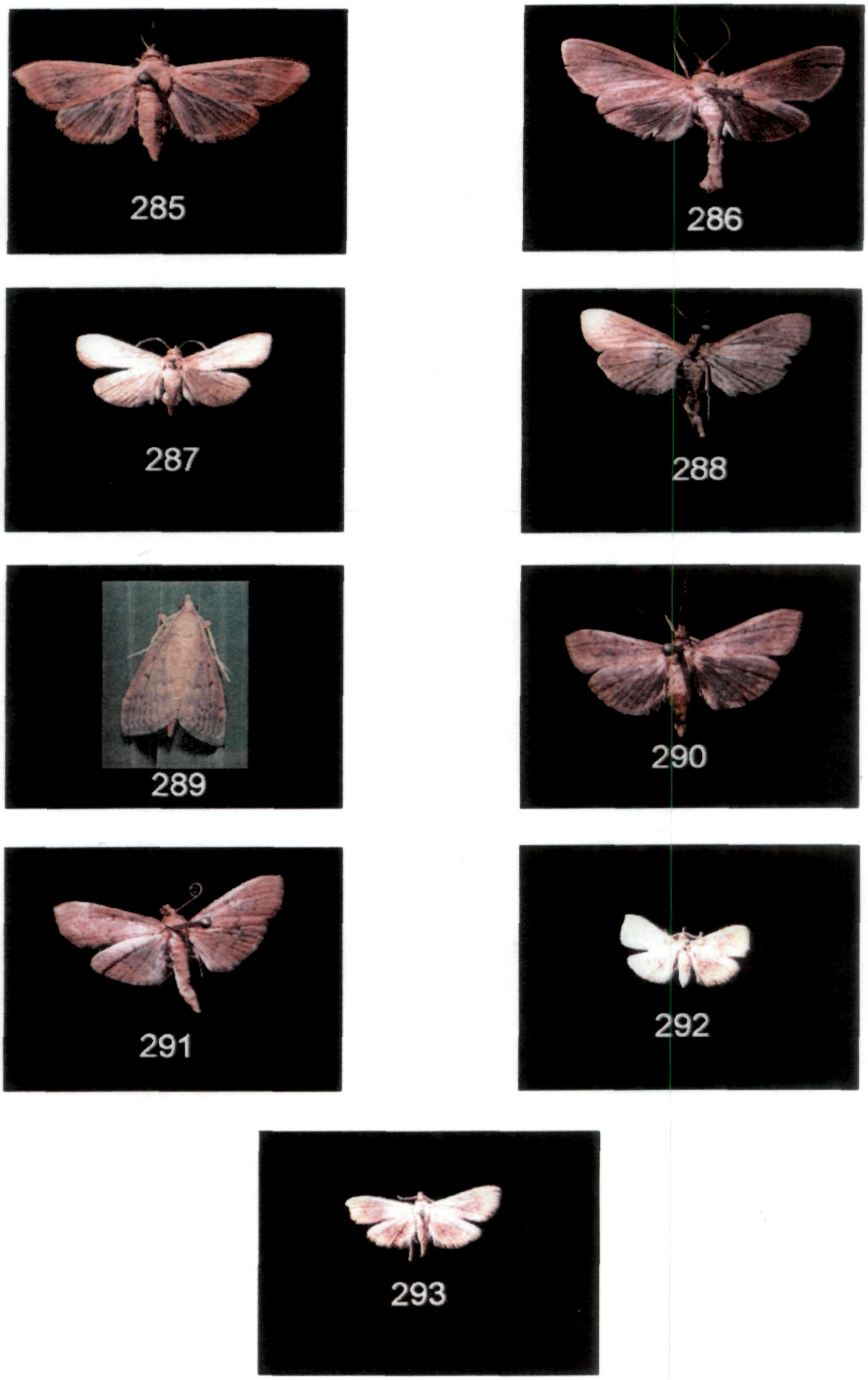

PLATE 25

DORSAL VIEW OF ADULTS

FIGSURS	DETAILS
294, female; 295, male	*Notarcha obrinusalis* (Walker)
296, female; 297, male	*Pleuroptya balteata* (Fabricius)
298, female; 299, male	*Schoenobius immeritalis* (Walker)
300, female	*Scirpophaga fusciflua* Hampson

Plate25

294

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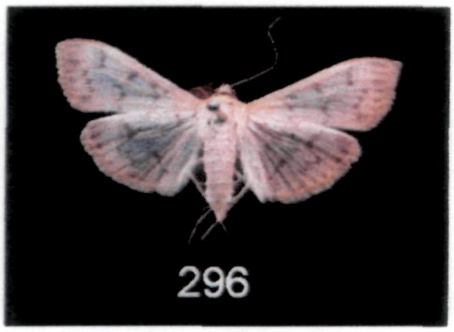

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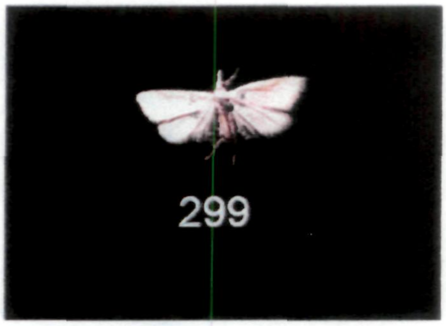

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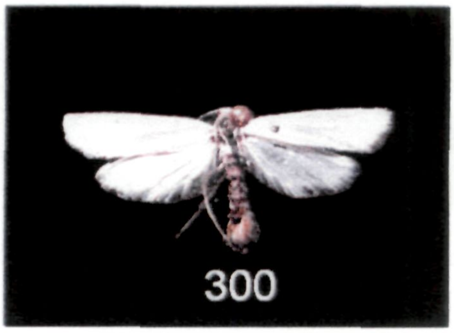

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PLATE 26

DORSAL VIEW OF ADULTS

FIGSURS	DETAILS
301, female; 302, male	*Scirpophaga gilviberbis* Zeller
303, 305, female; 304, 306 male	*Scirpophaga incertulas* (Walker)
307, female; 308, male	*Scirpophaga nivella* (Fabricius)

Plate 26


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PLATE 27

BIONOMICS

FIGURES	DETAILS
309, 310	Eggs
311, 312	1st instar larvae
313, 314	2nd instar larvae
315, 316	3rd instar larvae
317	4th instar larva
318, 319	5th instar larvae
320	5th instar larva just before pupation
321, 322	Nature of Damage
323	Dorsal view of pupa
324	Lateral view of pupa
325	Ventral view of pupa
278, Plate 23	Adult female
279, Plate 23	Adult male

Plate 27

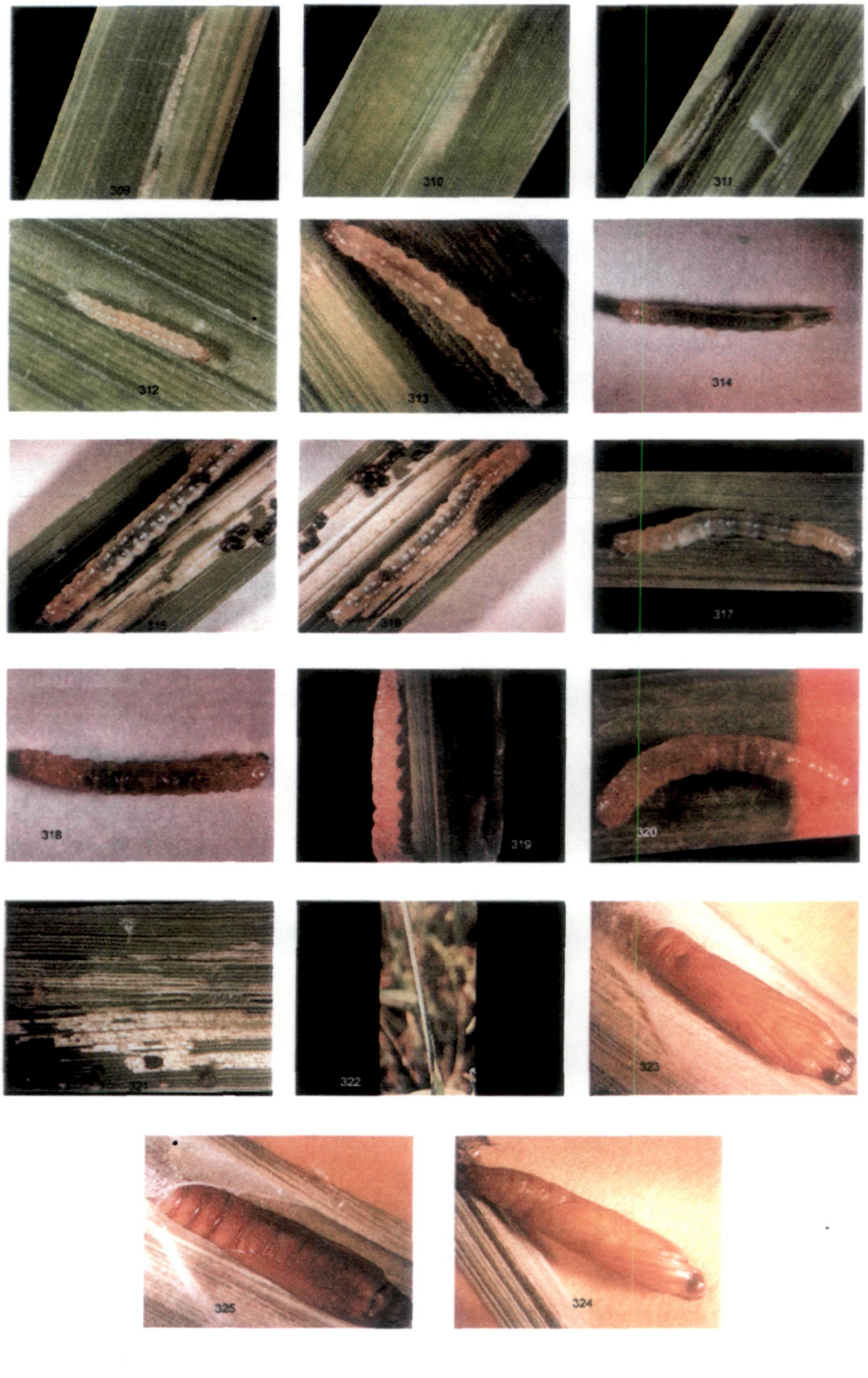
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Fig. 326: Monitoring of leaf folder population through light trap and net sweeping in relation to wheather factors (1997)

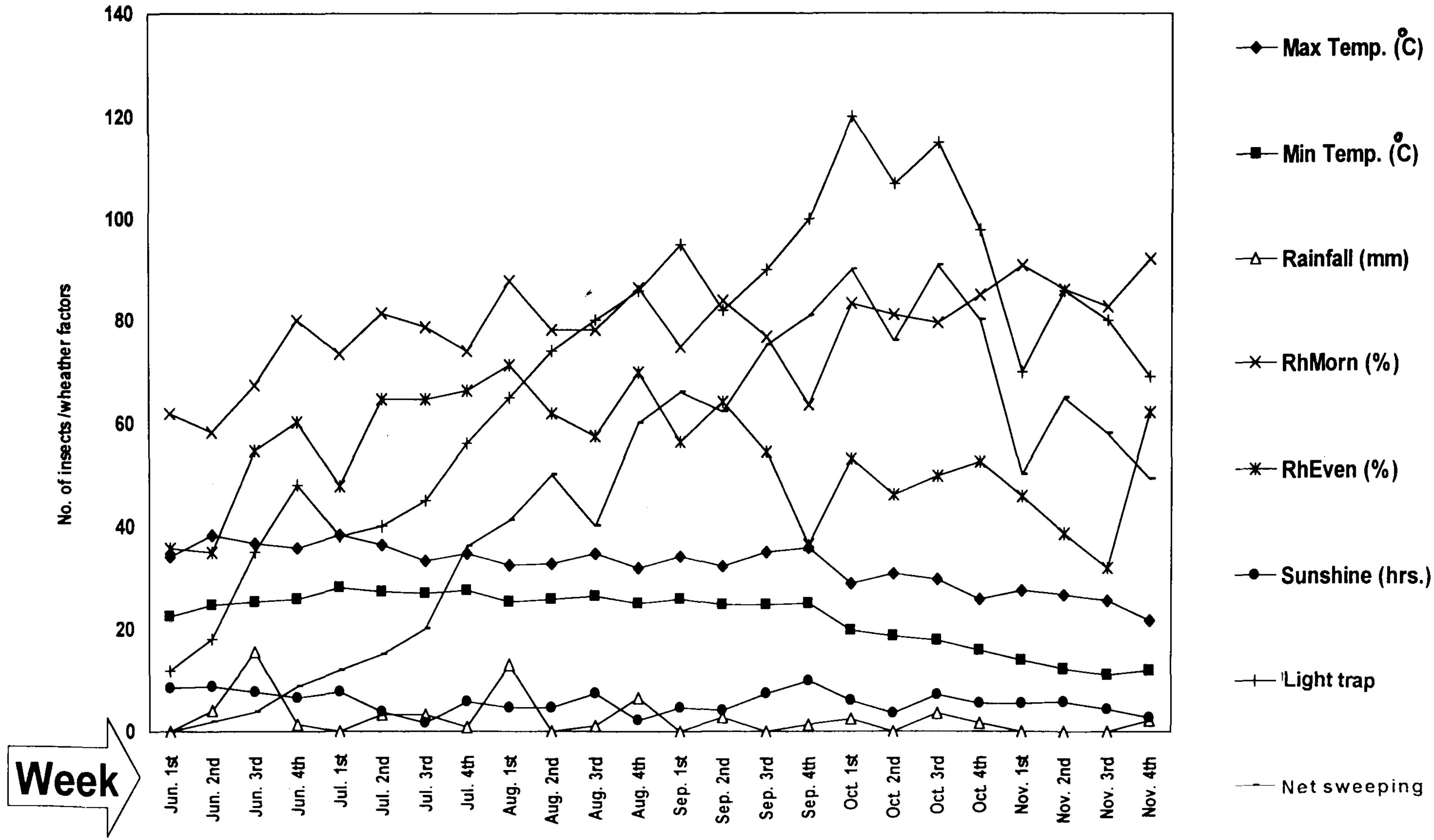


Fig. 327: Monitoring of leaf folder population through light trap and net sweeping in relation to wheather factors (1998)

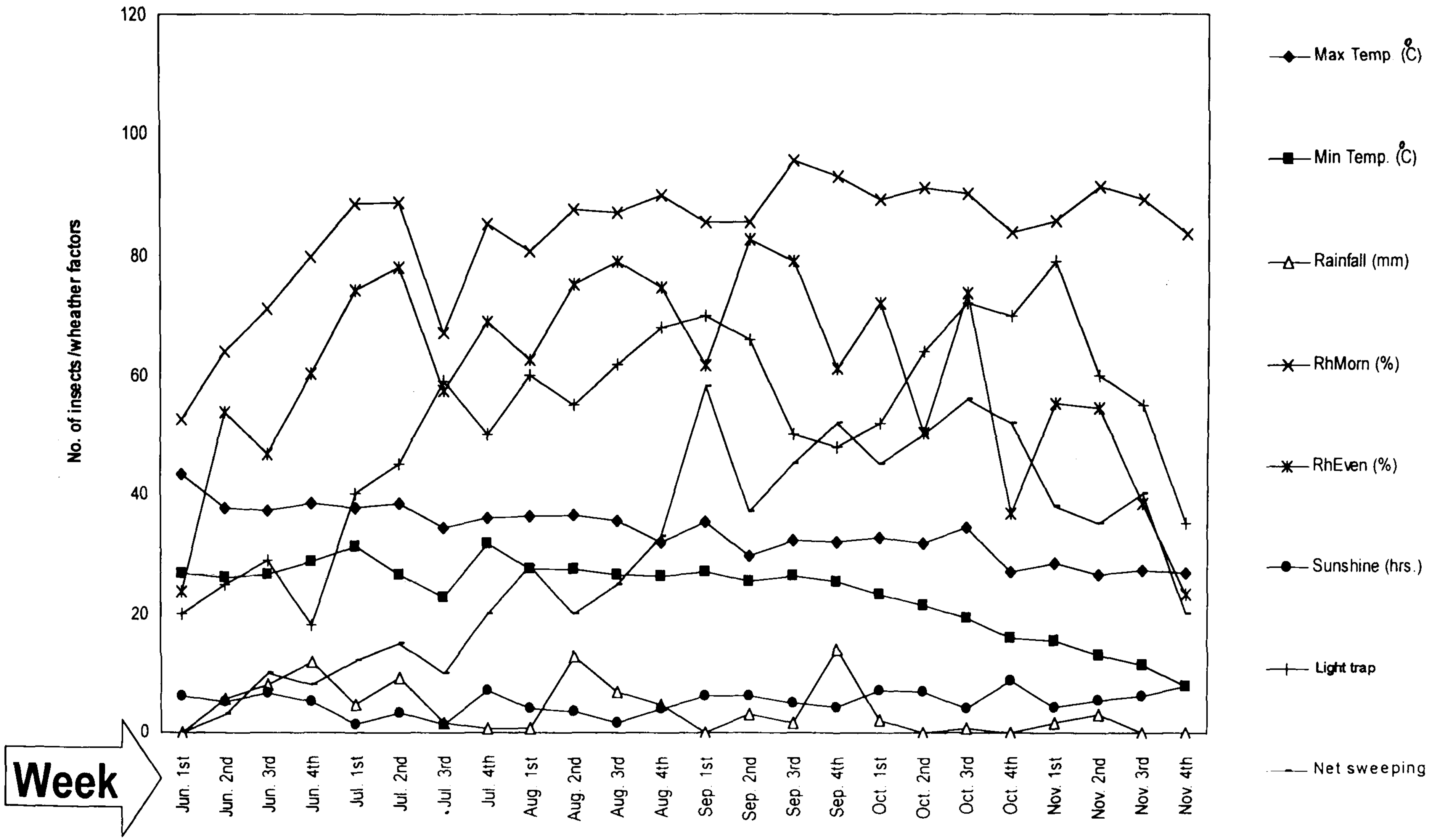


Fig. 328: Monitoring of leaf folder population through light trap and net sweeping in relation to wheather factors (1999)

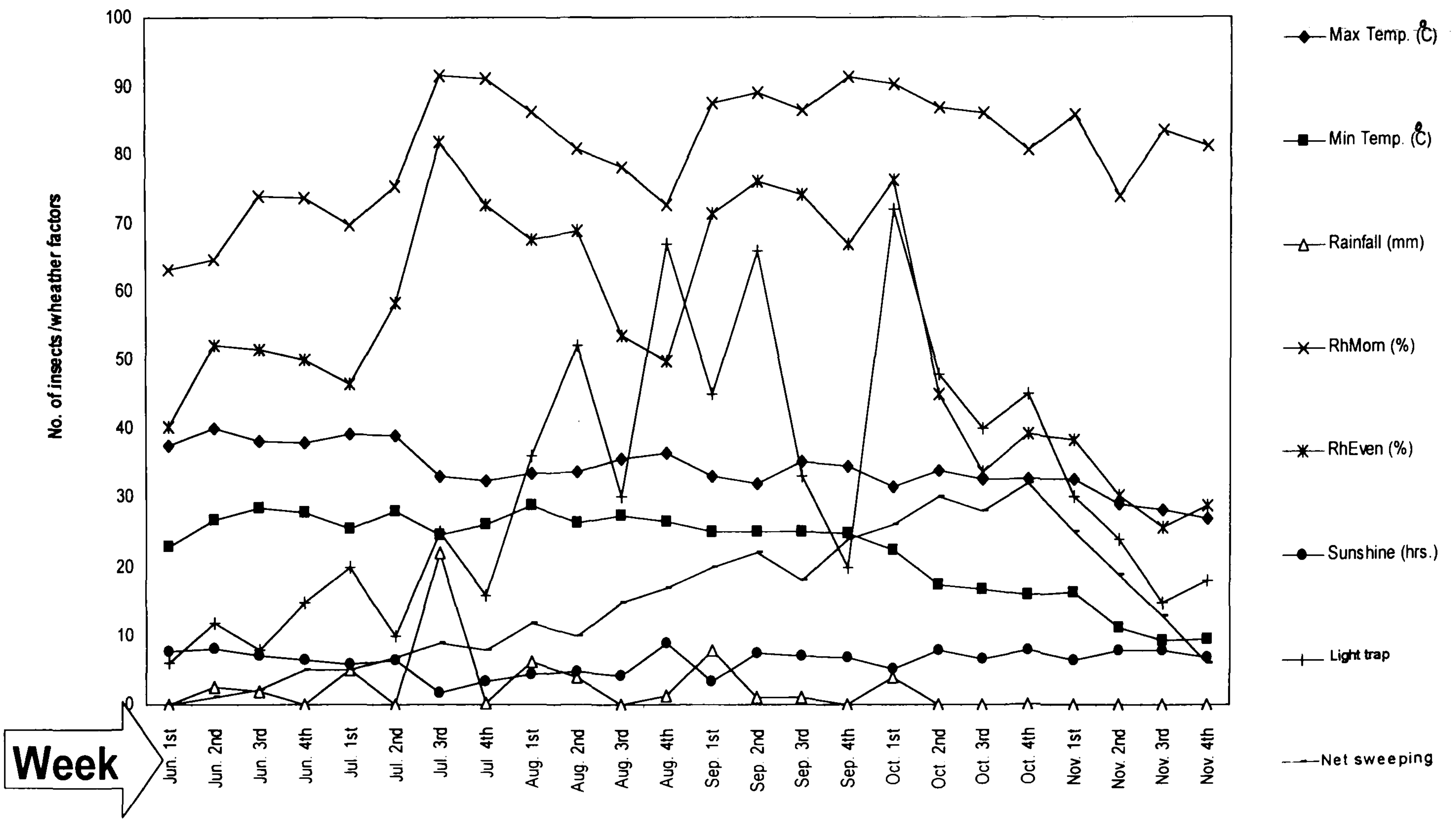


Fig. 329: Monitoring of leaf folder population through light trap and net sweeping in relation to wheather factors (2000)

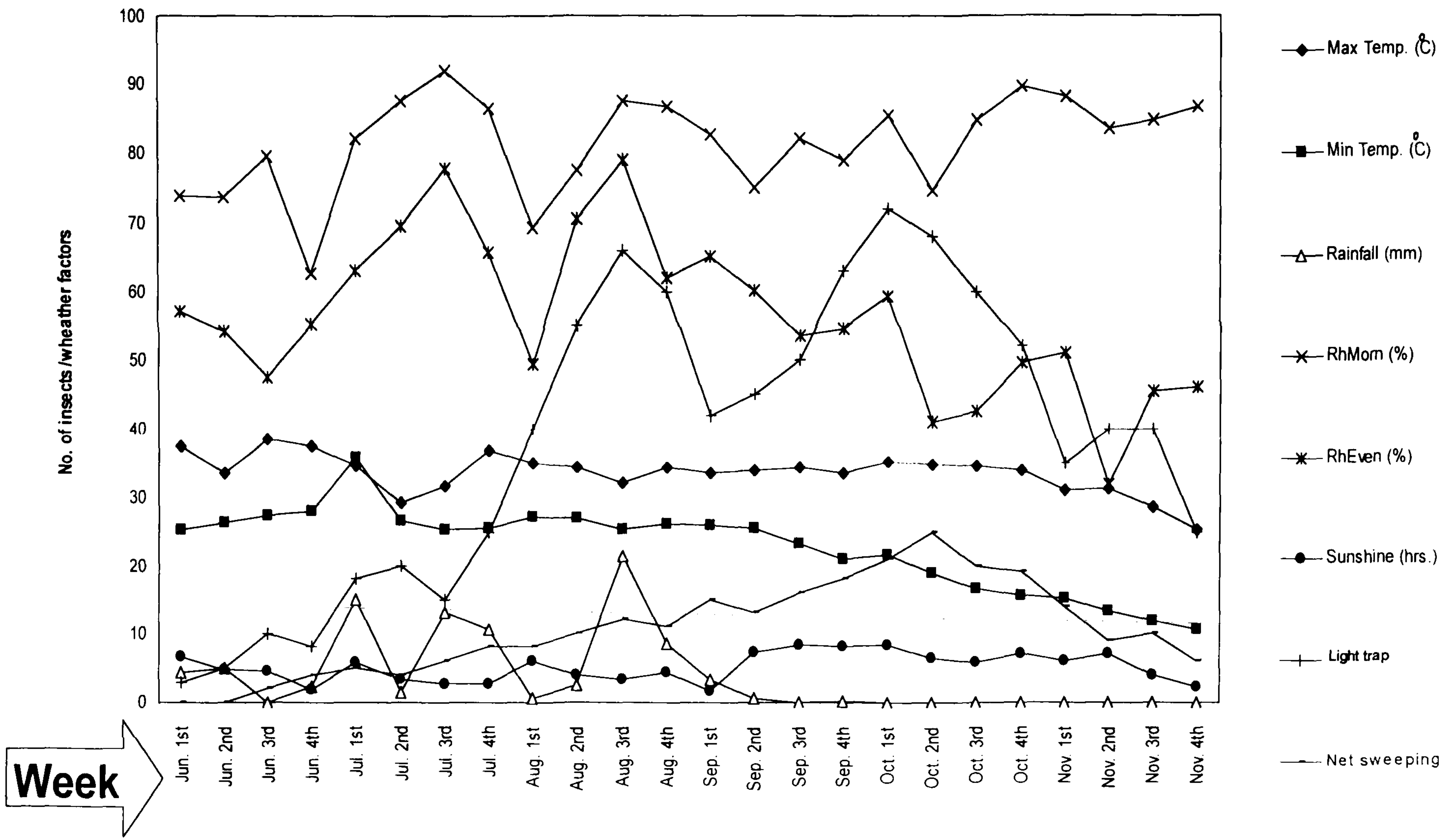


Fig. 330: Monitoring of leaf folder larval population and damage in relation to weather factors (1997)

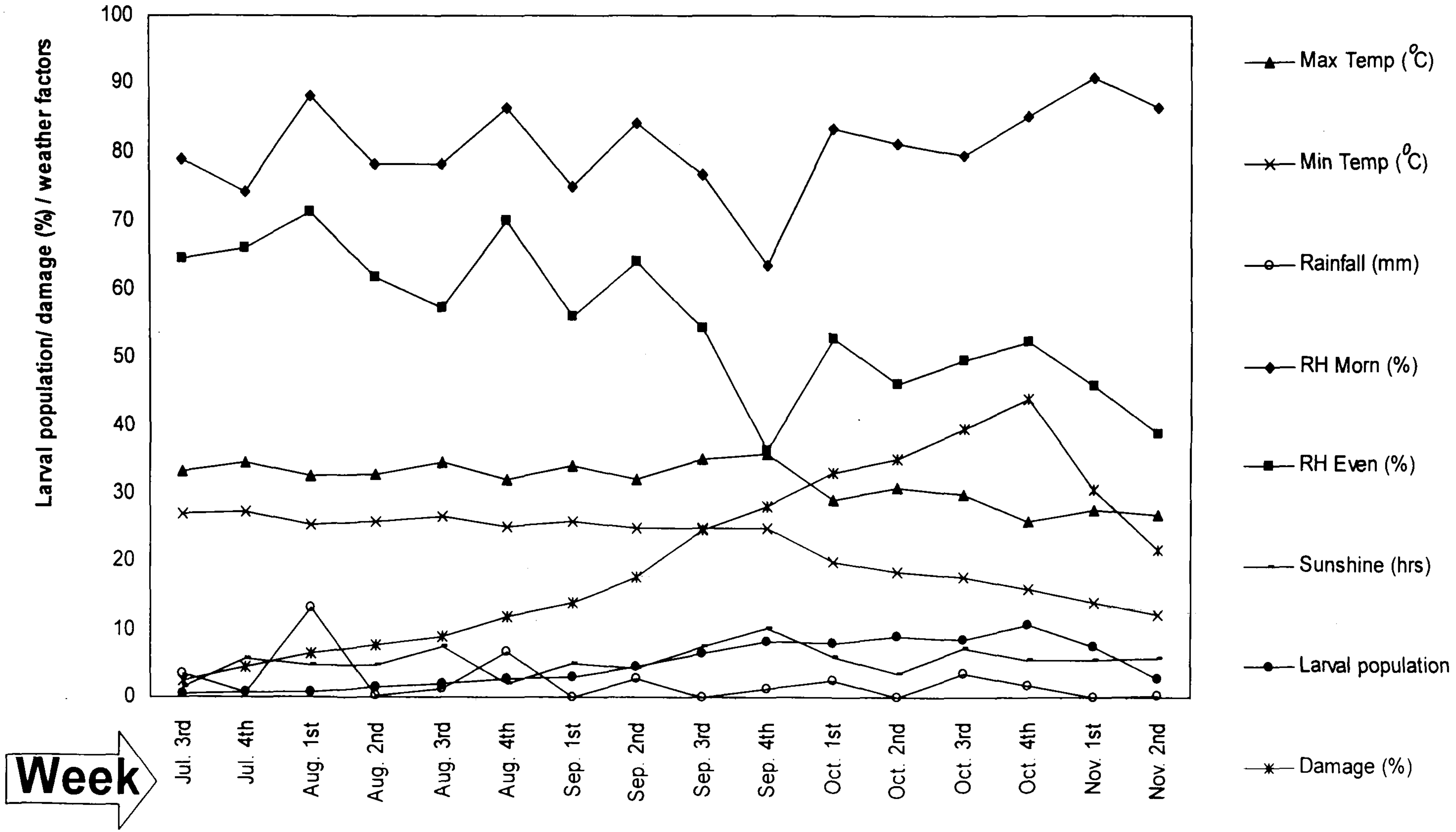


Fig. 331: Monitoring of leaf folder larval population and damage in relation to weather factors (1998)

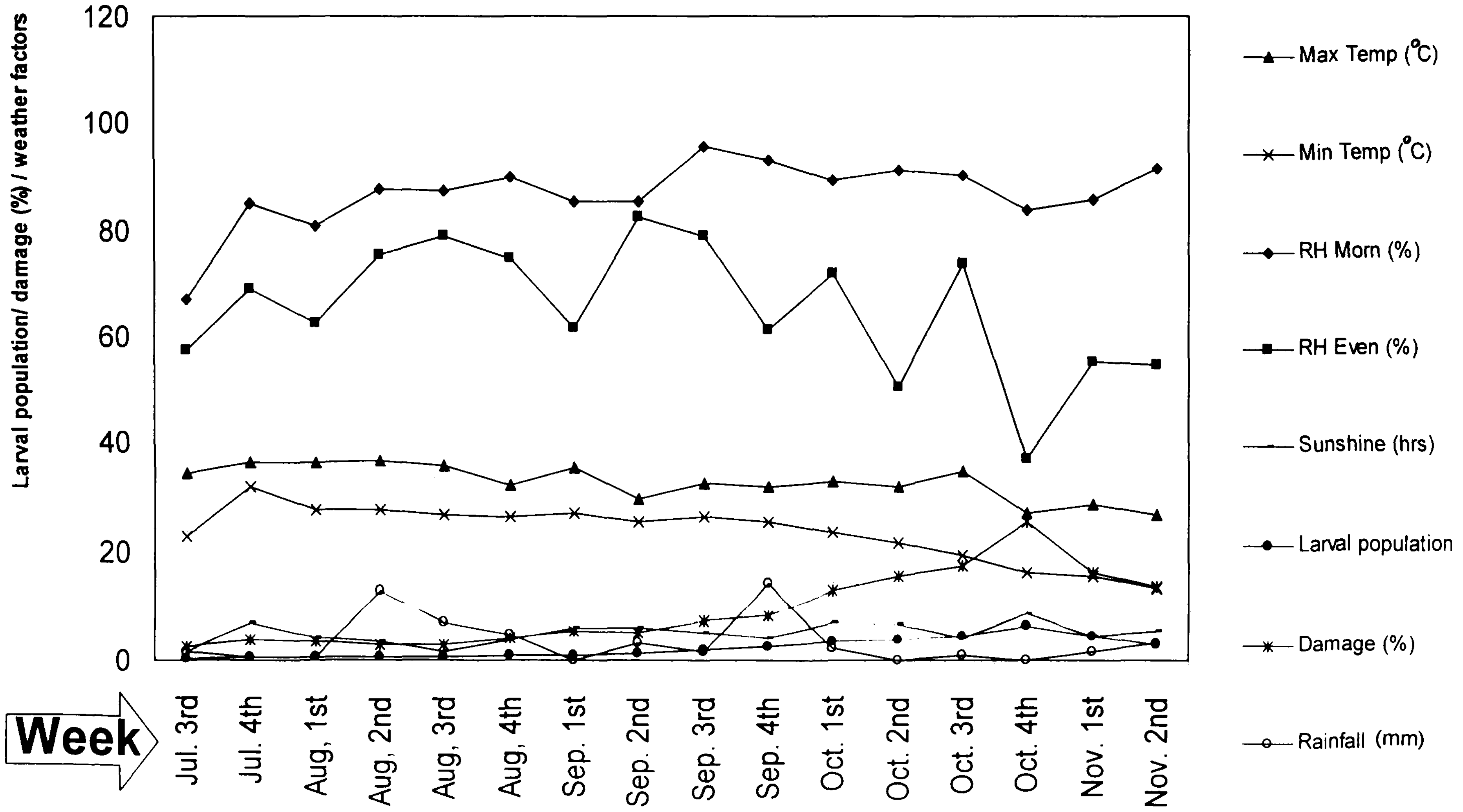


Fig. 332: Monitoring of leaf folder larval population and damage in relation to weather factors (1999)

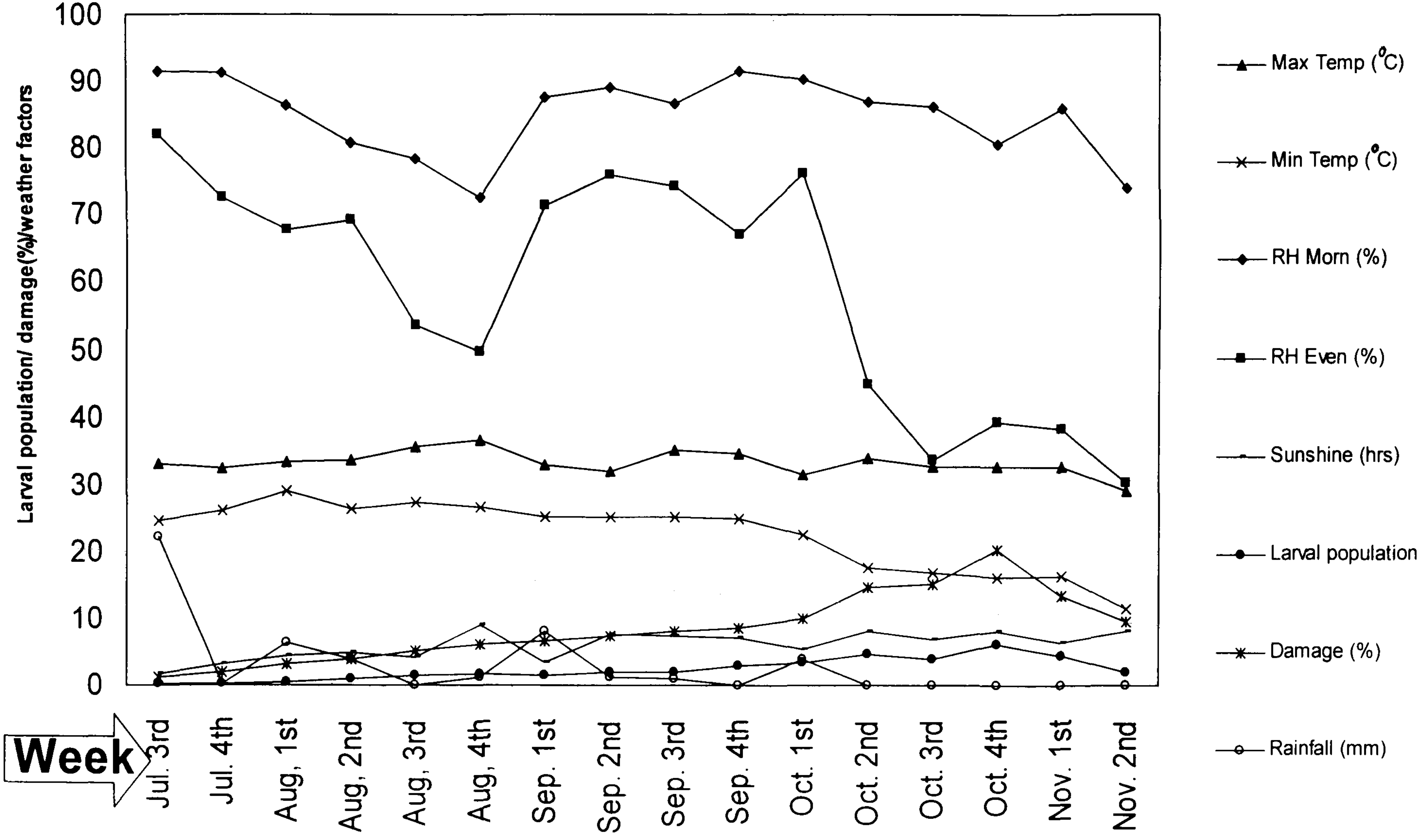


Fig. 333: Monitoring of leaf folder larval population and damage in relation to weather factors (2000)

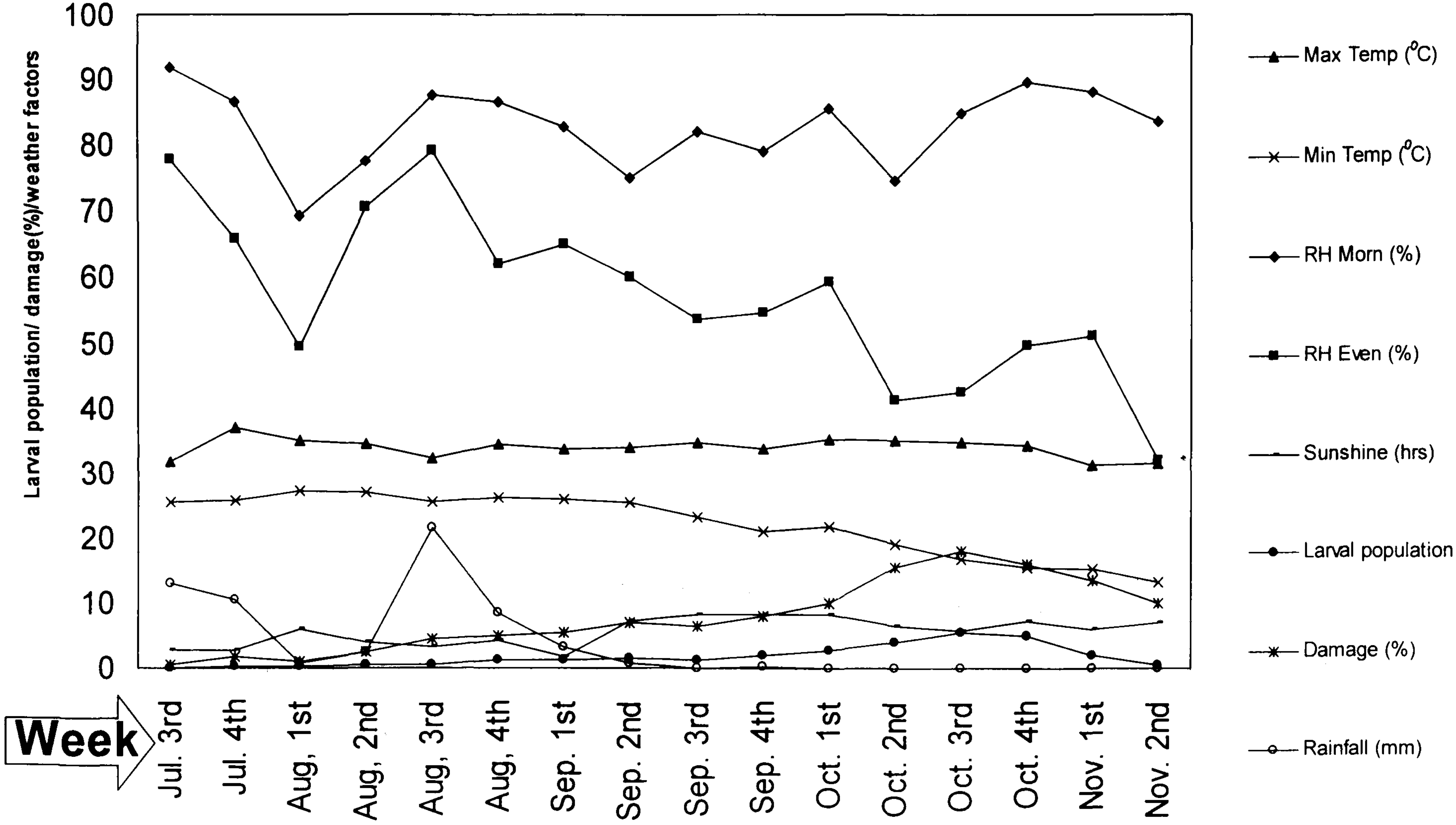


Fig. 334: Monitoring of leaf folder larval and pupal parasitization in relation to weather factors (1997)

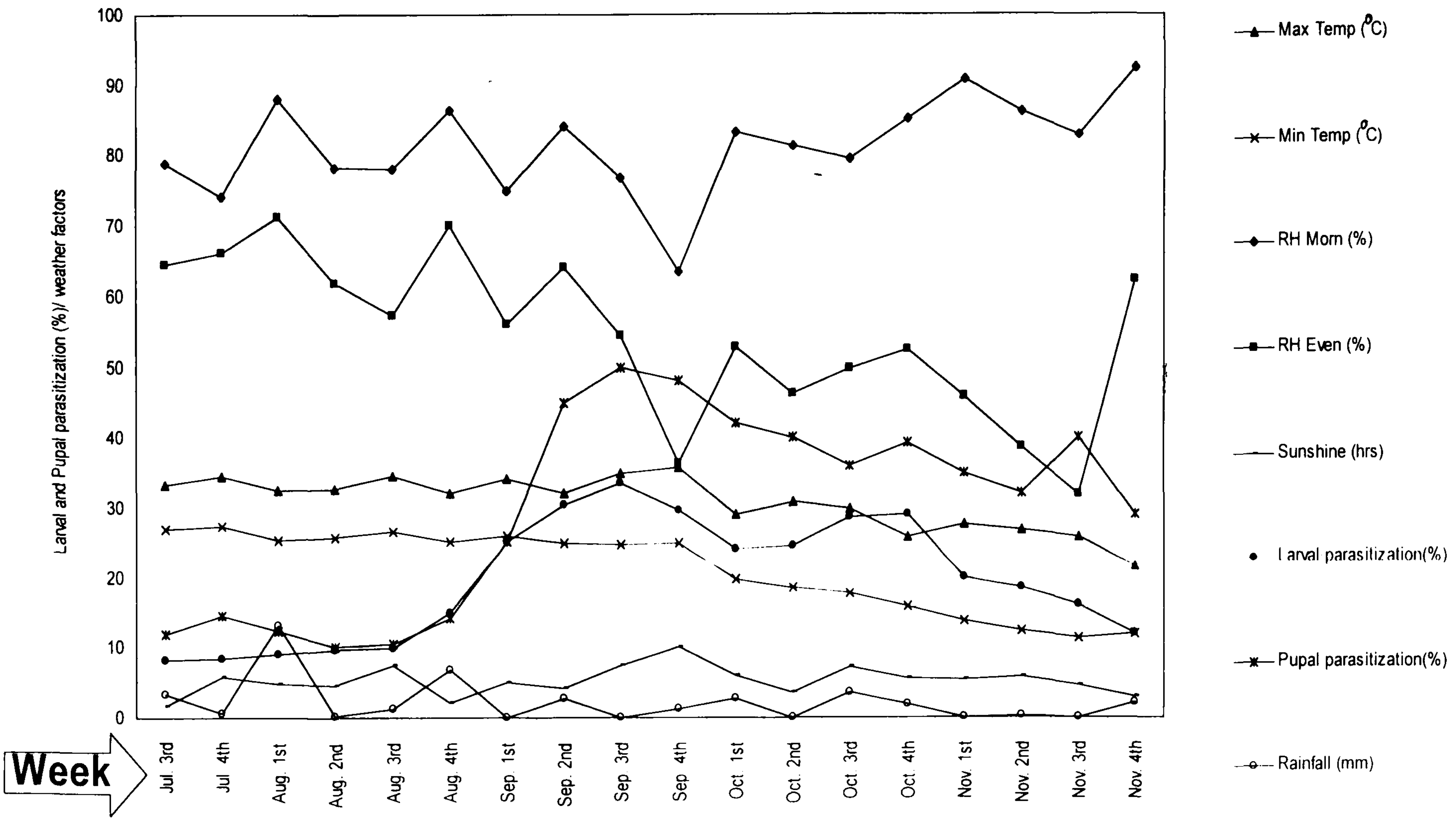


Fig. 335: Monitoring of leaf folder larval and pupal parasitization in relation to weather factors (1998)

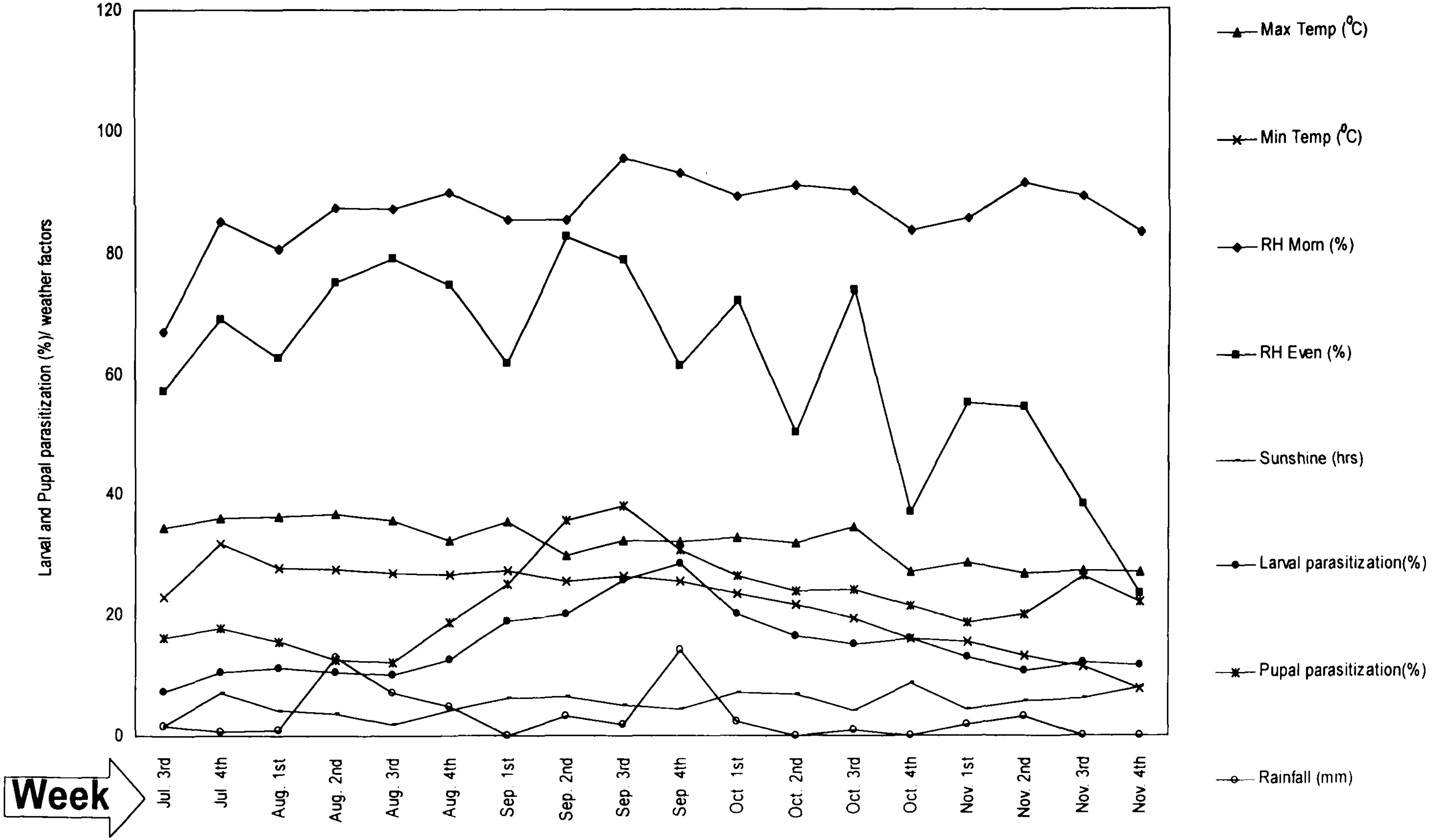


Fig. 336: Monitoring of leaf folder larval and pupal parasitization in relation to weather factors (1999)

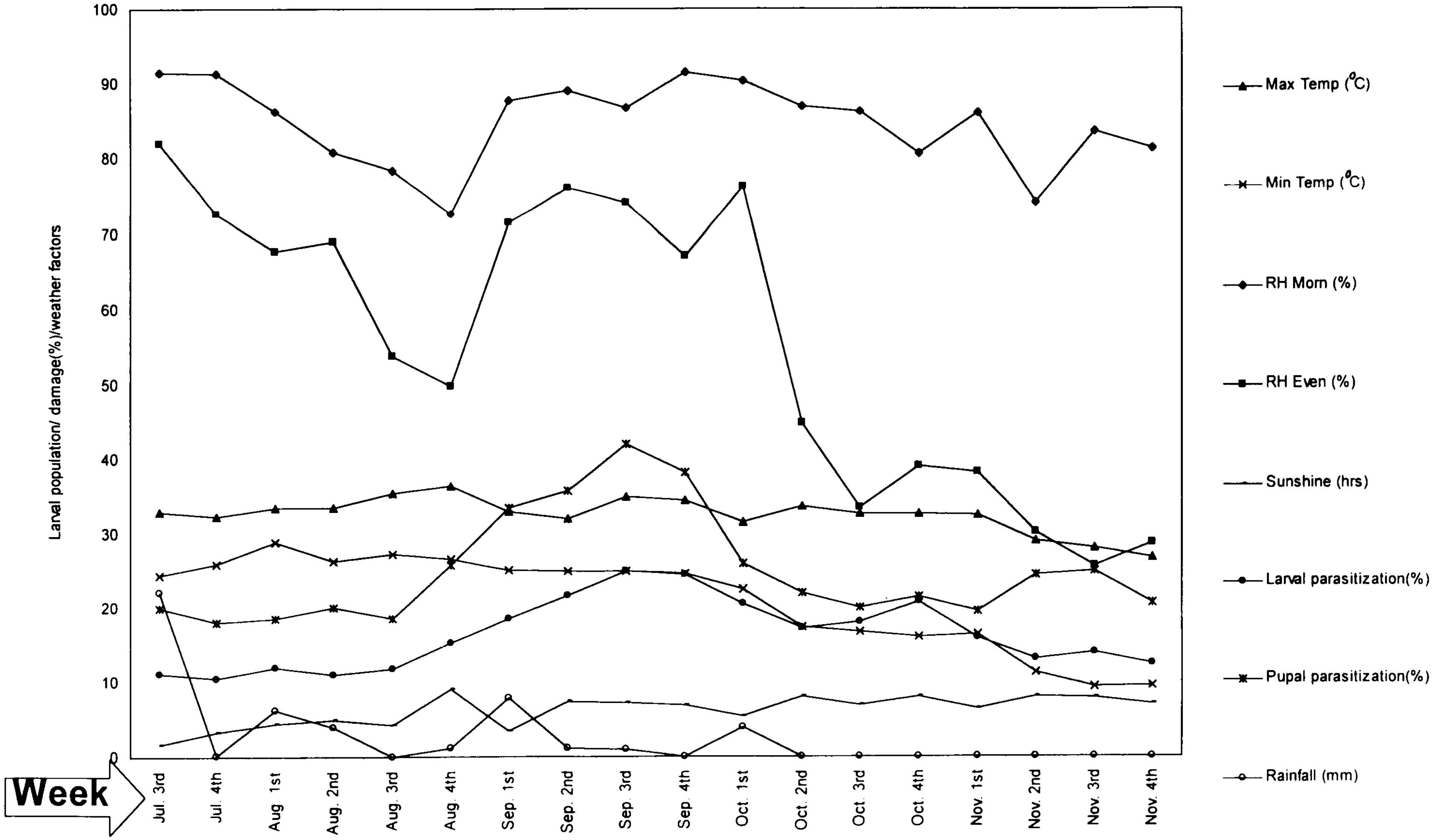
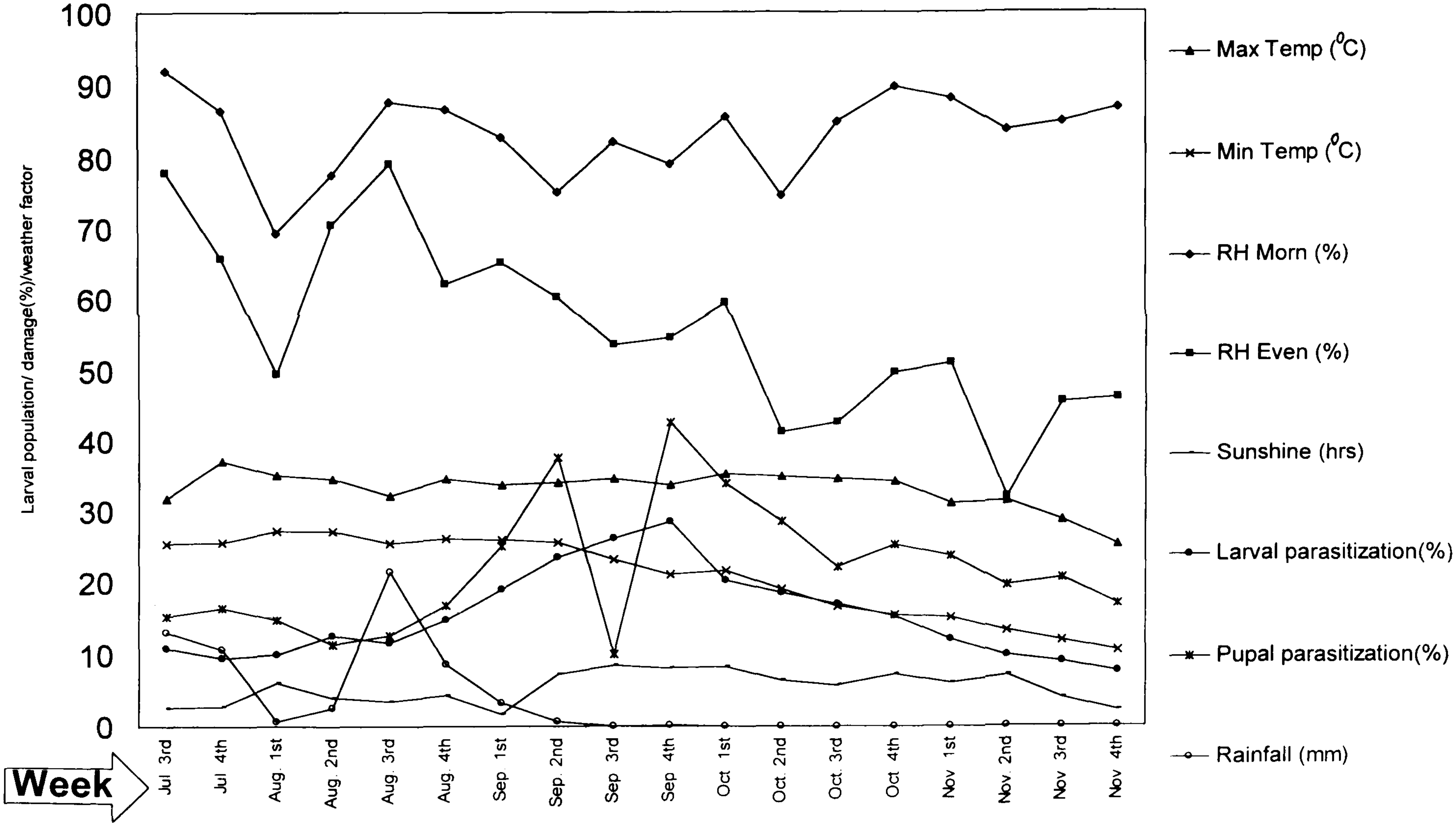


Fig. 337: Monitoring of leaf folder larval and pupal parasitization in relation to weather factors (2000)



TABLES

TABLE 6: MONITORING OF LEAF FOLDER POPULATION THROUGH LIGH TRAP AND NET SWEEPING IN RELATION TO WEATHER FACTORS (1997)

Month	Week	Max. Temp. (^{0}C)	Min Temp. (^{0}C)	Rainfall (mm)	RH Morn. (%)	RH Even. (%)	Sunshine (hrs)	No. of Insects (Light trap)	No. of Insects (Net sweeping)
June	I	34.20	22.50	0.00	61.70	35.70	8.54	12	0
	II	38.30	24.60	4.22	58.20	35.00	8.83	18	2
	III	36.50	25.30	15.57	67.50	54.70	7.72	35	4
	IV	35.90	25.70	1.37	80.25	60.20	6.53	48	9
July	I	38.24	27.91	0.00	73.42	47.71	7.80	38	12
	II	36.35	27.15	3.37	81.50	64.50	3.93	40	15
	III	33.36	27.00	3.35	78.87	64.50	1.57	45	20
	IV	34.57	27.31	0.70	74.12	66.12	5.76	56	36
August	I	32.40	25.27	13.05	88.00	71.26	4.68	65	41
	II	32.72	25.77	0.13	78.25	61.75	4.62	74	50
	III	34.56	26.45	1.13	78.12	57.25	7.48	80	40
	IV	32.01	25.08	6.71	86.37	70.00	2.08	86	60
September	I	34.00	25.91	0.00	74.85	56.14	4.85	95	66
	II	32.07	24.78	2.65	84.13	64.12	4.11	82	62
	III	34.87	24.74	0.00	76.71	54.42	7.48	90	75
	IV	35.68	24.84	1.30	63.50	36.25	10.07	100	81
October	I	28.97	19.74	2.57	83.42	52.85	5.97	120	90
	II	30.85	18.46	0.00	81.25	46.12	3.51	107	76
	III	29.73	17.65	3.47	79.50	49.75	7.11	115	91
	IV	25.75	15.82	1.75	85.12	52.37	5.57	98	80
November	I	27.45	13.82	0.00	90.85	45.85	5.43	70	50
	II	26.72	12.22	0.13	86.25	38.62	5.80	86	65
	III	25.62	11.21	0.00	83.00	31.85	4.47	80	58
	IV	21.65	12.00	2.15	92.37	62.13	2.91	69	49

TABLE 7: MONITORING OF LEAF FOLDER POPULATION THROUGH LIGH TRAP AND NET SWEEPING IN RELATION TO WEATHER FACTORS (1998)

Month	Week	Max. Temp. (^{0}C)	Min Temp. (^{0}C)	Rainfall (mm)	RH Morn. (%)	RH Even. (%)	Sunshine (hrs)	No. of Insects (Light trap)	No. of Insects (Net sweeping)
June	I	43.45	26.80	0.00	52.57	23.71	6.19	20	0
	II	37.80	26.16	5.62	64.00	53.80	5.25	25	3
	III	37.18	26.48	8.17	71.25	46.75	6.62	29	10
	IV	38.46	28.75	11.80	79.75	60.12	5.15	18	8
July	I	37.70	31.30	4.70	88.42	74.28	1.41	40	12
	II	38.31	26.63	9.30	88.75	78.12	3.37	45	15
	III	34.35	22.85	1.60	67.12	57.37	1.49	59	10
	IV	36.10	31.75	0.75	85.12	69.00	7.13	50	20
August	I	36.17	27.54	0.80	80.71	62.71	4.04	60	28
	II	36.62	27.48	12.85	87.50	75.25	3.55	55	20
	III	35.60	26.62	6.93	87.12	79.00	1.76	62	25
	IV	32.10	26.40	4.82	89.87	74.62	3.99	68	33
September	I	35.34	27.08	0.00	85.42	61.71	6.10	70	58
	II	29.65	25.37	3.08	85.37	82.62	6.25	66	37
	III	32.26	26.22	1.75	95.50	78.87	5.08	50	45
	IV	31.91	25.31	14.00	93.00	61.28	4.30	48	52
October	I	32.65	23.32	2.20	89.14	72.00	7.07	52	45
	II	31.80	21.40	0.00	91.12	50.37	6.78	64	50
	III	34.50	19.22	0.83	90.12	73.87	4.03	72	56
	IV	27.01	15.95	0.00	83.62	36.87	8.66	70	52
November	I	28.57	15.42	1.71	85.57	55.14	4.34	79	38
	II	26.66	13.06	3.12	91.37	54.62	5.57	60	35
	III	27.23	11.27	0.00	89.25	38.37	6.10	55	40
	IV	26.88	7.72	0.00	83.42	23.25	7.94	35	20

TABLE 8: MONITORING OF LEAF FOLDER POPULATION THROUGH LIGH TRAP AND NET SWEEPING IN RELATION TO WEATHER FACTORS (1999)

Month	Week	Max. Temp. (^{0}C)	Min Temp. (^{0}C)	Rainfall (mm)	RH Morn. (%)	RH Even. (%)	Sunshine (hrs)	No. of Insects (Light trap)	No. of Insects (Net sweeping)
June	I	37.42	22.97	0.00	63.25	40.12	7.76	6	0
	II	39.90	26.60	2.46	64.71	52.14	8.20	12	1
	III	38.02	28.28	1.97	73.85	51.42	7.21	8	2
	IV	37.80	27.66	0.00	73.75	50.00	6.55	15	5
July	I	39.08	25.37	5.12	69.71	46.42	5.90	20	5
	II	38.86	27.97	0.00	75.37	58.42	6.54	10	7
	III	33.06	24.53	22.14	91.50	82.00	1.72	25	9
	IV	32.35	26.02	0.21	91.25	72.62	3.27	16	8
August	I	33.45	28.88	6.22	86.28	67.57	4.47	36	12
	II	33.52	26.30	4.00	80.87	69.00	4.90	52	10
	III	35.41	27.25	0.00	78.25	53.62	4.24	30	15
	IV	36.40	26.53	1.17	72.62	49.75	9.08	67	17
September	I	32.93	25.06	7.92	87.62	71.37	3.46	45	20
	II	31.98	24.94	1.14	89.00	76.00	7.47	66	22
	III	34.98	25.02	0.95	86.62	74.12	7.21	33	18
	IV	34.51	24.71	0.00	91.42	67.00	6.97	20	24
October	I	31.47	22.42	4.00	90.37	76.25	5.35	72	26
	II	33.73	17.41	0.00	86.87	44.87	8.00	48	30
	III	32.60	16.71	0.00	86.14	33.57	6.82	40	28
	IV	32.62	16.07	0.00	80.62	39.12	8.00	45	32
November	I	32.58	16.40	0.00	86.00	38.28	6.44	30	25
	II	29.06	11.32	0.00	74.00	30.25	7.98	24	19
	III	28.10	9.35	0.00	83.57	25.57	7.95	15	13
	IV	26.83	9.58	0.00	81.25	28.71	7.03	18	6

TABLE 9: MONITORING OF LEAF FOLDER POPULATION THROUGH LIGH TRAP AND NET SWEEPING IN RELATION TO WEATHER FACTORS (2000)

Month	Week	Max. Temp. (^{0}C)	Min Temp. (^{0}C)	Rainfall (mm)	RH Morn. (%)	RH Even. (%)	Sunshine (hrs)	No. of Insects (Light trap)	No. of Insects (Net sweeping)
June	I	37.61	25.24	4.32	73.85	57.00	6.67	3	0
	II	33.55	26.28	5.05	73.75	54.25	4.72	5	0
	III	38.55	27.47	0.00	79.75	47.50	4.62	10	2
	IV	37.54	27.92	2.20	62.57	55.14	1.77	8	4
July	I	34.70	35.81	15.00	82.14	63.00	5.90	18	5
	II	29.32	26.63	1.46	87.50	69.50	3.22	20	4
	III	31.72	25.32	13.02	91.87	77.87	2.65	15	6
	IV	37.03	25.61	10.58	86.50	65.75	2.73	25	8
August	I	34.98	27.17	0.71	69.28	49.42	6.03	40	8
	II	34.45	27.03	2.52	77.50	70.50	4.02	55	10
	III	32.06	25.37	21.40	87.62	79.12	3.35	66	12
	IV	34.51	26.11	8.55	86.65	62.12	4.27	60	11
September	I	33.67	25.97	3.28	82.85	65.14	1.63	42	15
	II	34.03	25.56	0.63	75.13	60.13	7.26	45	13
	III	34.54	23.18	0.00	82.14	53.57	8.32	50	16
	IV	33.57	21.05	0.23	79.00	54.62	8.14	63	18
October	I	35.23	21.67	0.00	85.57	59.43	8.23	72	21
	II	34.86	18.96	0.00	74.62	41.13	6.38	68	25
	III	34.56	16.66	0.00	84.87	42.50	5.73	60	20
	IV	34.06	15.46	0.00	89.63	49.57	7.14	52	19
November	I	31.11	15.10	0.00	88.14	51.00	6.04	35	14
	II	31.41	13.20	0.00	83.63	31.88	7.08	40	9
	III	28.64	11.81	0.00	84.86	45.43	4.00	40	10
	IV	25.30	10.48	0.00	86.75	46.00	2.18	25	6

TABLE 10: MONITORING OF LEAF FOLDER LARVAL POPULATION AND DAMAGE IN RELATION TO WEATHER FACTORS (1997)

Month	Week	Max. Temp. (^{0}C)	Min Temp. (^{0}C)	Rainfall (mm)	RH Morn. (%)	RH Even. (%)	Sunshine (hrs)	Larval Population/ Hill	Damage (%)
July	III	33.36	27.00	3.35	78.87	64.50	1.57	0.50	2.50
	IV	34.57	27.31	0.70	74.12	66.12	5.76	0.75	4.50
August	I	32.40	25.27	13.05	88.00	71.26	4.68	0.75	6.50
	II	32.72	25.77	0.13	78.25	61.75	4.62	1.50	7.80
	III	34.56	26.45	1.13	78.12	57.25	7.48	2.00	9.00
	IV	32.01	25.08	6.71	86.37	70.00	2.08	2.80	12.00
September	I	34.00	25.91	0.00	74.85	56.14	4.85	3.00	14.00
	II	32.07	24.78	2.65	84.13	64.12	4.11	4.50	17.50
	III	34.87	24.74	0.00	76.71	54.42	7.48	6.40	24.60
	IV	35.68	24.84	1.30	63.50	36.25	10.07	8.25	28.00
October	I	28.97	19.74	2.57	83.42	52.85	5.97	8.00	33.00
	II	30.85	18.46	0.00	81.25	46.12	3.51	9.00	35.00
	III	29.73	17.65	3.47	79.50	49.75	7.11	8.50	39.50
	IV	25.75	15.82	1.75	85.12	52.37	5.57	10.60	44.00
November	I	27.45	13.82	0.00	90.85	45.85	5.43	7.50	30.50
	II	26.72	12.22	0.13	86.25	38.62	5.80	2.80	21.50

TABLE 11: MONITORING OF LEAF FOLDER LARVAL POPULATION AND DAMAGE IN RELATION TO WEATHER FACTORS (1998)

Month	Week	Max. Temp. (^{0}C)	Min Temp. (^{0}C)	Rainfall (mm)	RH Morn. (%)	RH Even. (%)	Sunshine (hrs)	Larval Population/ Hill	Damage (%)
July	III	34.35	22.85	1.60	67.12	57.37	1.49	0.25	2.50
	IV	36.10	31.75	0.75	85.12	69.00	7.13	0.50	3.75
August	I	36.17	27.54	0.80	80.71	62.71	4.04	0.50	3.50
	II	36.62	27.48	12.85	87.50	75.25	3.55	0.75	3.00
	III	35.60	26.62	6.93	87.12	79.00	1.76	0.50	2.80
	IV	32.10	26.40	4.82	89.87	74.62	3.99	1.00	4.20
September	I	35.34	27.08	0.00	85.42	61.71	6.10	1.00	5.50
	II	29.65	25.37	3.08	85.37	82.62	6.25	1.40	5.00
	III	32.26	26.22	1.75	95.50	78.87	5.08	2.00	7.50
	IV	31.91	25.31	14.00	93.00	61.28	4.30	2.50	8.40
October	I	32.65	23.32	2.20	89.14	72.00	7.07	3.50	12.90
	II	31.80	21.40	0.00	91.12	50.37	6.78	4.00	15.50
	III	34.50	19.22	0.83	90.12	73.87	4.03	4.50	17.20
	IV	27.01	15.95	0.00	83.62	36.87	8.66	6.50	25.40
November	I	28.57	15.42	1.71	85.57	55.14	4.34	4.50	16.20
	II	26.66	13.06	3.12	91.37	54.62	5.57	3.00	13.50

TABLE 12: MONITORING OF LEAF FOLDER LARVAL POPULATION AND DAMAGE IN RELATION TO WEATHER FACTORS (1999)

Month	Week	Max. Temp. (^{0}C)	Min Temp. (^{0}C)	Rainfall (mm)	RH Morn. (%)	RH Even. (%)	Sunshine (hrs)	Larval Population/ Hill	Damage (%)
July	III	33.06	24.53	22.14	91.50	82.00	1.72	0.25	1.28
	IV	32.35	26.02	0.21	91.25	72.62	3.27	0.25	1.87
August	I	33.45	28.88	6.22	86.28	67.57	4.47	0.50	3.08
	II	33.52	26.30	4.00	80.87	69.00	4.90	1.00	4.00
	III	35.41	27.25	0.00	78.25	53.62	4.24	1.50	5.17
	IV	36.40	26.53	1.17	72.62	49.75	9.08	1.80	6.00
September	I	32.93	25.06	7.92	87.62	71.37	3.46	1.50	6.50
	II	31.98	24.94	1.14	89.00	76.00	7.47	2.00	7.20
	III	34.98	25.02	0.95	86.62	74.12	7.21	2.00	8.00
	IV	34.51	24.71	0.00	91.42	67.00	6.97	3.00	8.60
October	I	31.47	22.42	4.00	90.37	76.25	5.35	3.50	10.00
	II	33.73	17.41	0.00	86.87	44.87	8.00	4.70	14.50
	III	32.60	16.71	0.00	86.14	33.57	6.82	4.00	15.00
	IV	32.62	16.07	0.00	80.62	39.12	8.00	6.00	20.25
November	I	32.58	16.40	0.00	86.00	38.28	6.44	4.50	13.50
	II	29.06	11.32	0.00	74.00	30.25	7.98	2.00	9.40

TABLE 13: MONITORING OF LEAF FOLDER LARVAL POPULATION AND DAMAGE IN RELATION TO WEATHER FACTORS (2000)

Month	Week	Max. Temp. (^{0}C)	Min Temp. (^{0}C)	Rainfall (mm)	RH Morn. (%)	RH Even. (%)	Sunshine (hrs)	Larval Population/ Hill	Damage (%)
July	III	31.72	25.32	13.02	91.87	77.87	2.65	0.10	0.50
	IV	37.03	25.61	10.58	86.50	65.75	2.73	0.25	1.80
August	I	34.98	27.17	0.71	69.28	49.42	6.03	0.25	1.00
	II	34.45	27.03	2.52	77.50	70.50	4.02	0.50	2.50
	III	32.06	25.37	21.40	87.62	79.12	3.35	0.50	4.50
	IV	34.51	26.11	8.55	86.65	62.12	4.27	1.20	5.00
September	I	33.67	25.97	3.28	82.85	65.14	1.63	1.20	5.60
	II	34.03	25.56	0.63	75.13	60.13	7.26	1.50	7.00
	III	34.54	23.18	0.00	82.14	53.57	8.32	1.25	6.50
	IV	33.57	21.05	0.23	79.00	54.62	8.14	2.00	8.00
October	I	35.23	21.67	0.00	85.57	59.43	8.23	2.75	10.00
	II	34.86	18.96	0.00	74.62	41.13	6.38	4.00	15.50
	III	34.56	16.66	0.00	84.87	42.50	5.73	5.50	18.00
	IV	34.06	15.46	0.00	89.63	49.57	7.14	5.00	16.00
November	I	31.11	15.10	0.00	88.14	51.00	6.04	2.00	13.50
	II	31.41	13.20	0.00	83.63	31.88	7.08	0.50	10.00

TABLE 14: MONITORING OF LEAF FOLDER LARVAL AND PUPAL PARASITIZATION IN RELATION TO WEATHER FACTORS (1997)

Month	Week	Max. Temp. (^{0}C)	Min Temp. (^{0}C)	Rainfall (mm)	RH Morn. (%)	RH Even. (%)	Sunshine (hrs)	Larval Parasitization (%)	Pupal Parasitization (%)
July	III	33.36	27.00	3.35	78.87	64.50	1.57	8.20	12.00
	IV	34.57	27.31	0.70	74.12	66.12	5.76	8.50	14.50
August	I	32.40	25.27	13.05	88.00	71.26	4.68	9.00	12.25
	II	32.72	25.77	0.13	78.25	61.75	4.62	9.55	10.00
	III	34.56	26.45	1.13	78.12	57.25	7.48	9.90	10.50
	IV	32.01	25.08	6.71	86.37	70.00	2.08	15.00	14.20
September	I	34.00	25.91	0.00	74.85	56.14	4.85	25.00	25.00
	II	32.07	24.78	2.65	84.13	64.12	4.11	30.32	45.00
	III	34.87	24.74	0.00	76.71	54.42	7.48	33.50	50.00
	IV	35.68	24.84	1.30	63.50	36.25	10.07	29.50	48.00
October	I	28.97	19.74	2.57	83.42	52.85	5.97	24.00	42.00
	II	30.85	18.46	0.00	81.25	46.12	3.51	24.50	40.00
	III	29.73	17.65	3.47	79.50	49.75	7.11	28.50	36.00
	IV	25.75	15.82	1.75	85.12	52.37	5.57	29.00	39.20
November	I	27.45	13.82	0.00	90.85	45.85	5.43	20.00	35.00
	II	26.72	12.22	0.13	86.25	38.62	5.80	18.50	32.00
	III	25.62	11.21	0.00	83.00	31.85	4.47	16.00	40.00
	IV	21.65	12.00	2.15	92.37	62.13	2.91	12.00	29.00

TABLE 15: MONITORING OF LEAF FOLDER LARVAL AND PUPAL PARASITIZATION IN RELATION TO WEATHER FACTORS (1998)

Month	Week	Max. Temp. (^{o}C)	Min Temp. (^{o}C)	Rainfall (mm)	RH Morn. (%)	RH Even. (%)	Sunshine (hrs)	Larval Parasitization (%)	Pupal Parasitization (%)
July	III	34.35	22.85	1.60	67.12	57.37	1.49	7.25	16.00
	IV	36.10	31.75	0.75	85.12	69.00	7.13	10.50	17.75
August	I	36.17	27.54	0.80	80.71	62.71	4.04	11.12	15.50
	II	36.62	27.48	12.85	87.50	75.25	3.55	10.50	12.50
	III	35.60	26.62	6.93	87.12	79.00	1.76	10.00	12.00
	IV	32.10	26.40	4.82	89.87	74.62	3.99	12.35	18.50
September	I	35.34	27.08	0.00	85.42	61.71	6.10	18.75	25.00
	II	29.65	25.37	3.08	85.37	82.62	6.25	20.00	35.50
	III	32.26	26.22	1.75	95.50	78.87	5.08	25.50	38.00
	IV	31.91	25.31	14.00	93.00	61.28	4.30	28.20	30.50
October	I	32.65	23.32	2.20	89.14	72.00	7.07	20.00	26.20
	II	31.80	21.40	0.00	91.12	50.37	6.78	16.25	23.80
	III	34.50	19.22	0.83	90.12	73.87	4.03	15.00	24.00
	IV	27.01	15.95	0.00	83.62	36.87	8.66	15.75	21.25
November	I	28.57	15.42	1.71	85.57	55.14	4.34	13.00	18.50
	II	26.66	13.06	3.12	91.37	54.62	5.57	10.75	20.00
	III	27.23	11.27	0.00	89.25	38.37	6.10	12.00	26.20
	IV	26.88	7.72	0.00	83.42	23.25	7.94	11.50	22.00

TABLE 16: MONITORING OF LEAF FOLDER LARVAL AND PUPAL PARASITIZATION IN RELATION TO WEATHER FACTORS (1999)

Month	Week	Max. Temp. (^{0}C)	Min Temp. (^{0}C)	Rainfall (mm)	RH Morn. (%)	RH Even. (%)	Sunshine (hrs)	Larval Parasitization (%)	Pupal Parasitization (%)
July	III	33.06	24.53	22.14	91.50	82.00	1.72	11.10	20.00
	IV	32.35	26.02	0.21	91.25	72.62	3.27	10.50	18.00
August	I	33.45	28.88	6.22	86.28	67.57	4.47	12.00	18.50
	II	33.52	26.30	4.00	80.87	69.00	4.90	11.00	20.00
	III	35.41	27.25	0.00	78.25	53.62	4.24	11.75	18.50
	IV	36.40	26.53	1.17	72.62	49.75	9.08	15.25	25.75
September	I	32.93	25.06	7.92	87.62	71.37	3.46	18.50	33.50
	II	31.98	24.94	1.14	89.00	76.00	7.47	21.75	35.75
	III	34.98	25.02	0.95	86.62	74.12	7.21	25.00	42.00
	IV	34.51	24.71	0.00	91.42	67.00	6.97	24.50	38.20
October	I	31.47	22.42	4.00	90.37	76.25	5.35	20.50	26.00
	II	33.73	17.41	0.00	86.87	44.87	8.00	17.25	22.00
	III	32.60	16.71	0.00	86.14	33.57	6.82	18.00	20.00
	IV	32.62	16.07	0.00	80.62	39.12	8.00	20.80	21.50
November	I	32.58	16.40	0.00	86.00	38.28	6.44	16.00	19.50
	II	29.06	11.32	0.00	74.00	30.25	7.98	13.20	24.50
	III	28.10	9.35	0.00	83.57	25.57	7.95	14.00	25.00
	IV	26.83	9.58	0.00	81.25	28.71	7.03	12.50	20.75
	IV	33.57	21.05	0.23	79.00	54.62	8.14	28.50	42.50

TABLE 17: MONITORING OF LEAF FOLDER LARVAL AND PUPAL PARASITIZATION IN RELATION TO WEATHER FACTORS (2000)

Month	Week	Max. Temp. (°C)	Min Temp. (°C)	Rainfall (mm)	RH Morn. (%)	RH Even. (%)	Sunshine (hrs)	Larval Parasitization (%)	Pupal Parasitization (%)
July	III	31.72	25.32	13.02	91.87	77.87	2.65	10.75	15.25
	IV	37.03	25.61	10.58	86.50	65.75	2.73	9.50	16.50
August	I	34.98	27.17	0.71	69.28	49.42	6.03	10.00	14.75
	II	34.45	27.03	2.52	77.50	70.50	4.02	12.50	11.25
	III	32.06	25.37	21.40	87.62	79.12	3.35	11.50	12.60
	IV	34.51	26.11	8.55	86.65	62.12	4.27	14.75	16.75
September	I	33.67	25.97	3.28	82.85	65.14	1.63	19.00	25.00
	II	34.03	25.56	0.63	75.13	60.13	7.26	23.50	37.50
	III	34.54	23.18	0.00	82.14	53.57	8.32	26.00	10.00
	IV	33.57	21.05	0.23	79.00	54.62	8.14	28.50	42.50
October	I	35.23	21.67	0.00	85.57	59.43	8.23	20.20	33.75
	II	34.86	18.96	0.00	74.62	41.13	6.38	18.50	28.50
	III	34.56	16.66	0.00	84.87	42.50	5.73	17.00	22.10
	IV	34.06	15.46	0.00	89.63	49.57	7.14	15.25	25.25
November	I	31.11	15.10	0.00	88.14	51.00	6.04	12.00	23.75
	II	31.41	13.20	0.00	83.63	31.88	7.08	9.75	19.50
	III	28.64	11.81	0.00	84.86	45.43	4.00	9.00	20.50
	IV	25.30	10.48	0.00	86.75	46.00	2.18	7.50	17.00